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# Slave Finite Element for Non-Linear Analysis of Engine Structures

## Volume II—Programmer's Manual and User's Manual

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SLAVE FINITE ELEMENT FOR

NON-LINEAR ANALYSIS OF ENGINE STRUCTURES

PROGRAMMER'S MANUAL

## 1.0 INTRODUCTION

The programming aspects of SFENES are described in the User's Manual. The information presented here is provided for the installation programmer. It is sufficient to fully describe the general program logic and required peripheral storage. All element generated data is stored externally to reduce required memory allocation. A separate section is devoted to the description of these files thereby permitting the optimization of I/O time through efficient buffer description. Individual subroutine descriptions are presented along with the complete Fortran source listings. A short description of the major control, computation, and I/O phases is included to aid in obtaining an overall familiarity with the program's components. Finally, a discussion of the suggested overlay structure which allows the program to execute with a reasonable amount of memory allocation is presented.

## 2.0 GENERAL PROGRAM LOGIC

The general organization of the SFENES program is illustrated in Figures 1 thru 6. The element routines consists of a control program and four principal computation phases; namely,

1. Input interpretation phase
2. Spatial integrations and computations
3. Matrix computations and time assembly
4. Stress recovery and element output phase

### 2.1 Control Program (Figure 1)

Routine "INTRFC" controls the element computation flow. Initially, the "Input Phase" and "Spatial Computational Phase" are executed. These two phases are outside of the iterative phases and need only be executed once. Routine "INTRFC" then executes the "Matrix Computation and Temporal Assembly Phases". Control is referred to the "MAIN" program for all spatial assembly and displacement computations, $[K_F]\{u\}=\{F_D\}$. The "INTRFC" portion is re-entered for convergence checking and the stress recovery phase is then executed. The iterative process is repeated until convergence or the maximum number of iterations is achieved. The Control program is the interface between the element routines and the MAIN program unit.

### 2.2 Input Interpretation Phase (Figure 2)

The purpose of this phase is to read the formatted element input data and control data from the input file "IOIN". The data, in some cases (element loads and local grid coordinates), is used in additional computations and is finally output to binary files "IOEL", "IOLD", and "IOUS" for use by the remaining phases. This phase is only entered prior to the first iteration of the problem. Routine "INPUT" reads the formatted data, provides an echo print for the user and outputs all data to the output files. "GRIDG" computes all of the remaining grid point coordinates from local grid points 13-16 and the

corner thicknesses. Routine "LOADIN" reads the input element load data and computes the resulting grid point forces at the user input time increments.

## 2.3 Spatial Integrations and Computations (Figure 3 & 3A)

The "Spatial Computation Phase" is executed once prior to the first iteration. The function of this phase is to perform all spatial computations and any other "one" time computations which required spatial integrations. The primary tasks of this phase are outlined briefly below.

a) The volume, area, and surface definite integrals are computed for the polynomial terms $x^n y^m z^l$ and $\rho^k x^i y^j z^l$; $0 \leq n \leq 9$, $0 \leq m \leq 9$, $0 \leq l \leq 7$, $0 \leq k \leq 3$, $0 \leq i \leq 7$, $0 \leq j \leq 7$. These integrals are computed by routines VOLCOF, COLXYZ, CEAXYZ, CNLXYZ, CURCOF, CURPSI, CNRPSI, CURXYZ, CNRXYZ, TRLCOF, VOL-, VL-, REA-, RA-, SUR-, and SUP-.

b) Routine LOADD computes the element force vector {F} by combining the input element loads as a function of time, (file IOLD) the appropriate spatial integrals from (a) above, the Hermitian time functions, and integrations over the local time ranges. The resulting combination of element body force, pressure and traction forces are output to file "IOFO" for intersolution of $[K_F]\{u\}=\{F\}$ equation.

c) The final function of this phase is to compute and store the spatial matrix partitions of [M], [K], [X], [A], [B], $[C_e]$, $[B_{28}]$, $[P_{28}]$, [C], $[N_x']$, and $[P_{28}]\cdot[B_{28}]^{-1}$. These matrices are stored on file "IOCF", "ICPR", and "IOTP" for use by the third phase. The matrices computed in this task are reused in subsequent iterations since the shape functions are constant.

## 2.4 Matrix Computation and Time Assembly Phase (Figure 4)

The function of this phase is to compute the element stiffness and stress matrices for each local time range. This involves the computation of the $[E_6]$

matrices as a function of time, (routine EPQP19) and integrating over the local time intervals. The result of the time integrations is multiplied by the spatial matrices as computed in the spatial computation phase and assembled into the element $[K_e]$, $[S_e]$, $[A_e]$ and $[B_e]$ matrices for each local time interval. These computations may be made for either the linear elastic quad plate or the non-linear elastic-plastic quad plate elements (routines LEQP and EPQPB respectively). Spatial matrices are input from files "IOPR" and "IOTP" and prior iterative values of {w} and {σ} are input from file "IOUS". The "IOA0" and "IOA1" are used alternately to read the previous and store the current coefficients of polynomials in (t) used to compute the $[E_7]$ matrices. File "IOKE", "IOAE", "IOBE", and "IOLD" are output files for storing element $[K_e]$ $[A_e]$, $[B_e]$ and $[S_e]$ matrices respectively.

Routines "TBASEM" and "TABSEM" perform the temporal assembly of the element $[K_e]$ matrices for the "LEQP" anbd "EPQP" elements respectively. Files "IOKE", "IOCE", "IOBE", "IOAE" control the input to these routines and the final element $[K_f]$ matrices are output to file "IOKF". For the "EPQP" element the computation $[B_e]\cdot[C_e]^{-1}$ is stored on file "IOLD" for element stress computations.

**2.5 Stress Recovery and Element Output (Figure 5)**

The "CNVRG" routine checks for convergence of all displacement/velocity values and stores the latest value of {u} on file "IOUL" for the next iteration. Element stress is recovered in routines "CSIGO" or "CSIGL" for element types "EPQP" and "LEQP" respectively. The input to these routines is contained in files "IOTF", the current displacement/velocity values {u}, and "IOLD", the stress matrices [S] or $[C_e]^{-1}$ $[B_e]$. The displacement/velocity {u} and stress {σ} vectors are output to file "IOUS" to be used in the computation of $[E_7]$ for the next estimate of $[K_e]$. Printed output of selected grids displacement and/or stress values for each iteration is provided for by

routine "WRITO". This output is at the major time intervals only. Convergence of the problem initiates the extrapolation and output of displacement/velocity values at user specified time intervals within the major time increments.

## 2.6 Displacement Computation (Figure 6)

Control is returned to the "MAIN" program after the stiffness $[K_F]$ and stress [S] or $[C_e^{-1}] \cdot [B_e]$ matrices have been time assembled in the matrix computation phase. The "MAIN" program calls routine "COMPU" which performs the following functions:

a) Read the partitions of the $[K_f]$ matrix (see Figure 7 to Figure 9 for description of $[K_f]$ matrix)

b) Applies the user input boundary conditions to the individual partition (eliminates rows and columns) and forms the reduced $[K_F]$ matrix.

c) Eliminates all rows containing displacement related data at times T=0 and $T=t_N$ (rows 1-84 and rows 1N*168+1 to N*168+84 of the $[K_F]$ matrix).

d) Reads the $\{F_F\}$ vector partitions and time assembles the local partitions (see Figure 14 for a description of the assembled {F} vector).

e) Applies user input boundary conditions as in step b) and c) above to the $\{F_F\}$ vector rows.

f) Computes $\{u\} = [K_F^{-1}] \{F\}$ and stores data or file "IOTP" for stress recovery and output phase.

The newly computed displacement vector {u} is then read by the stress recovery phase and the next iteration is entered if required.

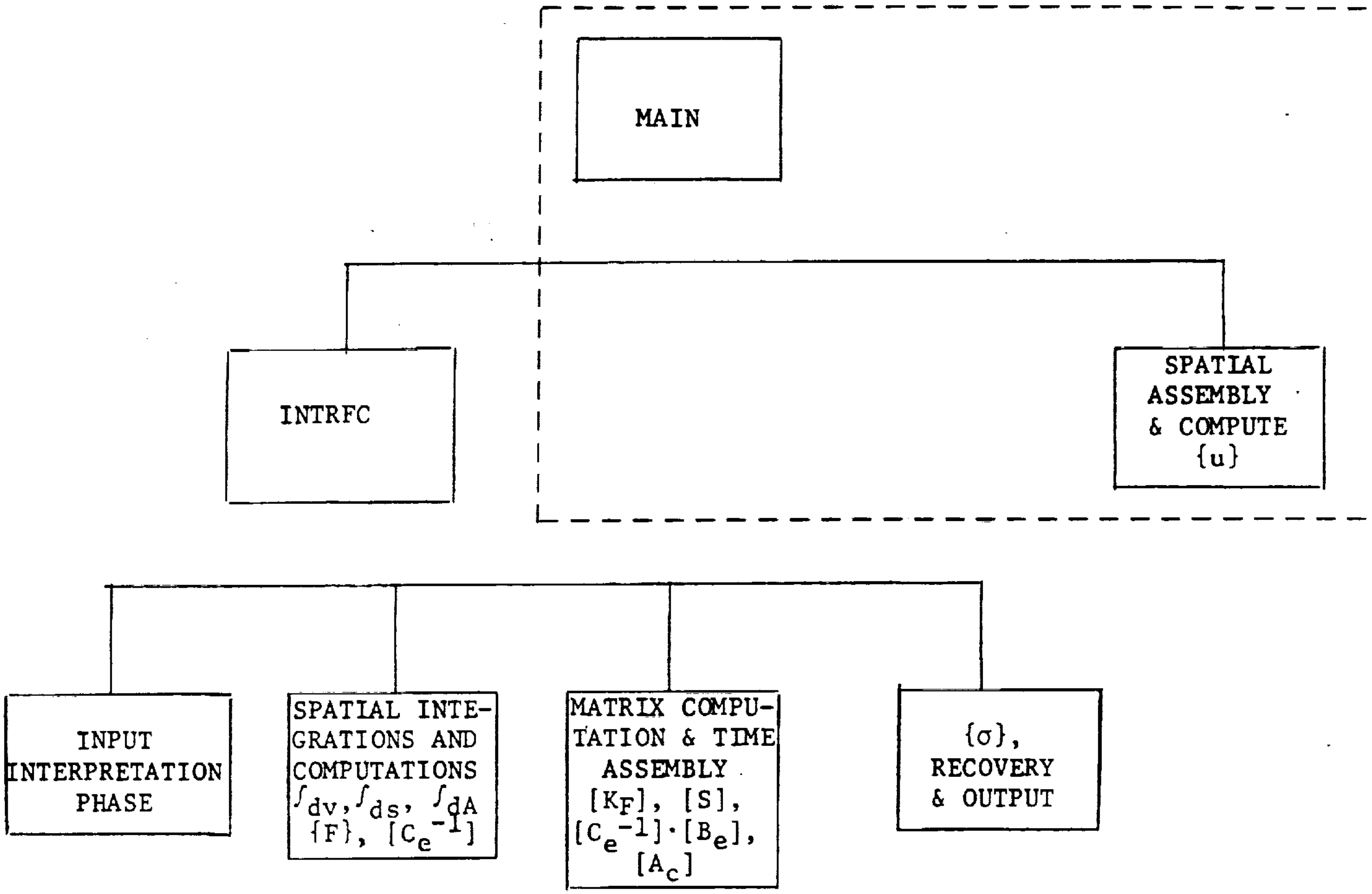
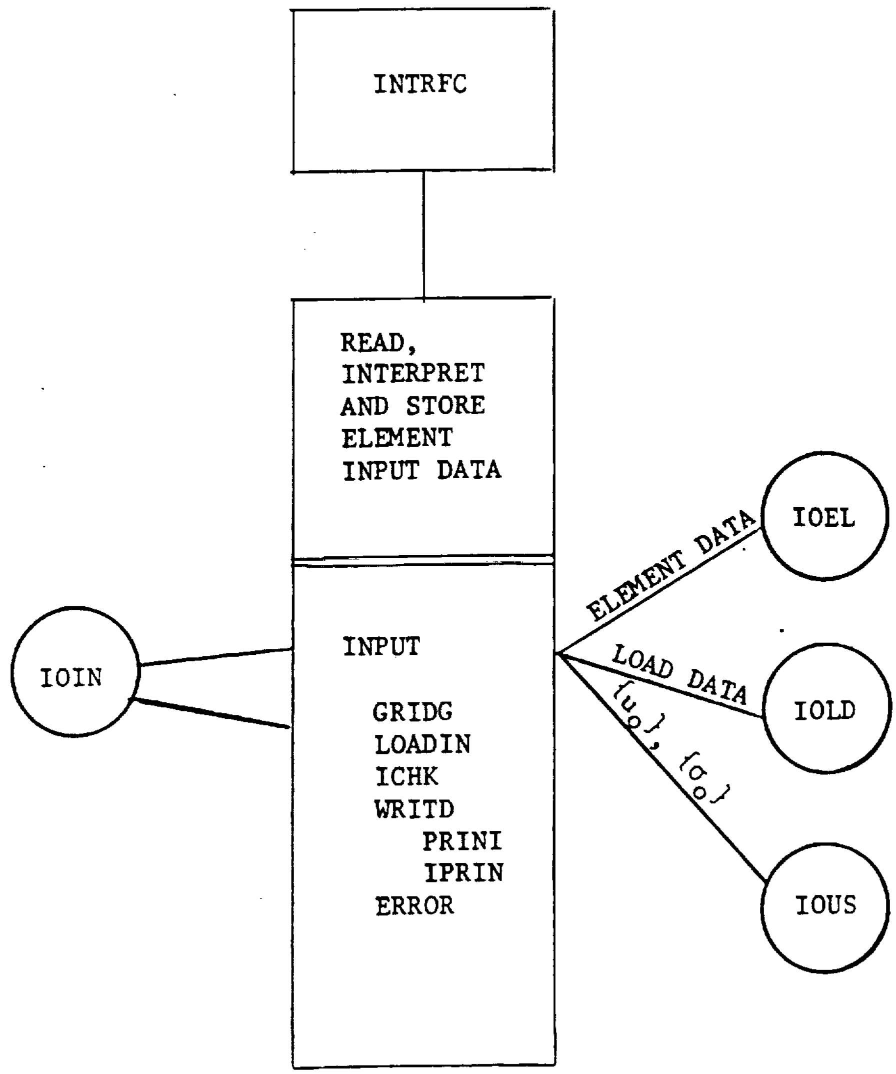

MAIN
INTRFC
SPATIAL ASSEMBLY & COMPUTE {u}
INPUT INTERPRETATION PHASE
SPATIAL INTEGRATIONS AND COMPUTATIONS $\int dv, \int ds, \int dA$ {F}, $[C_e^{-1}]$
MATRIX COMPUTATION & TIME ASSEMBLY $[K_F]$, [S], $[C_e^{-1}]\cdot[B_e]$, $[A_c]$
$\{\sigma\}$, RECOVERY & OUTPUT

FIGURE 1



INTRFC
READ,
INTERPRET
AND STORE
ELEMENT
INPUT DATA
INPUT
GRIDG
LOADIN
ICHK
WRITD
PRINI
IPRIN
ERROR
IOIN
IOEL
IOLD
IOUS
ELEMENT DATA
LOAD DATA
{u_o}, {σ_o}


FIGURE 2

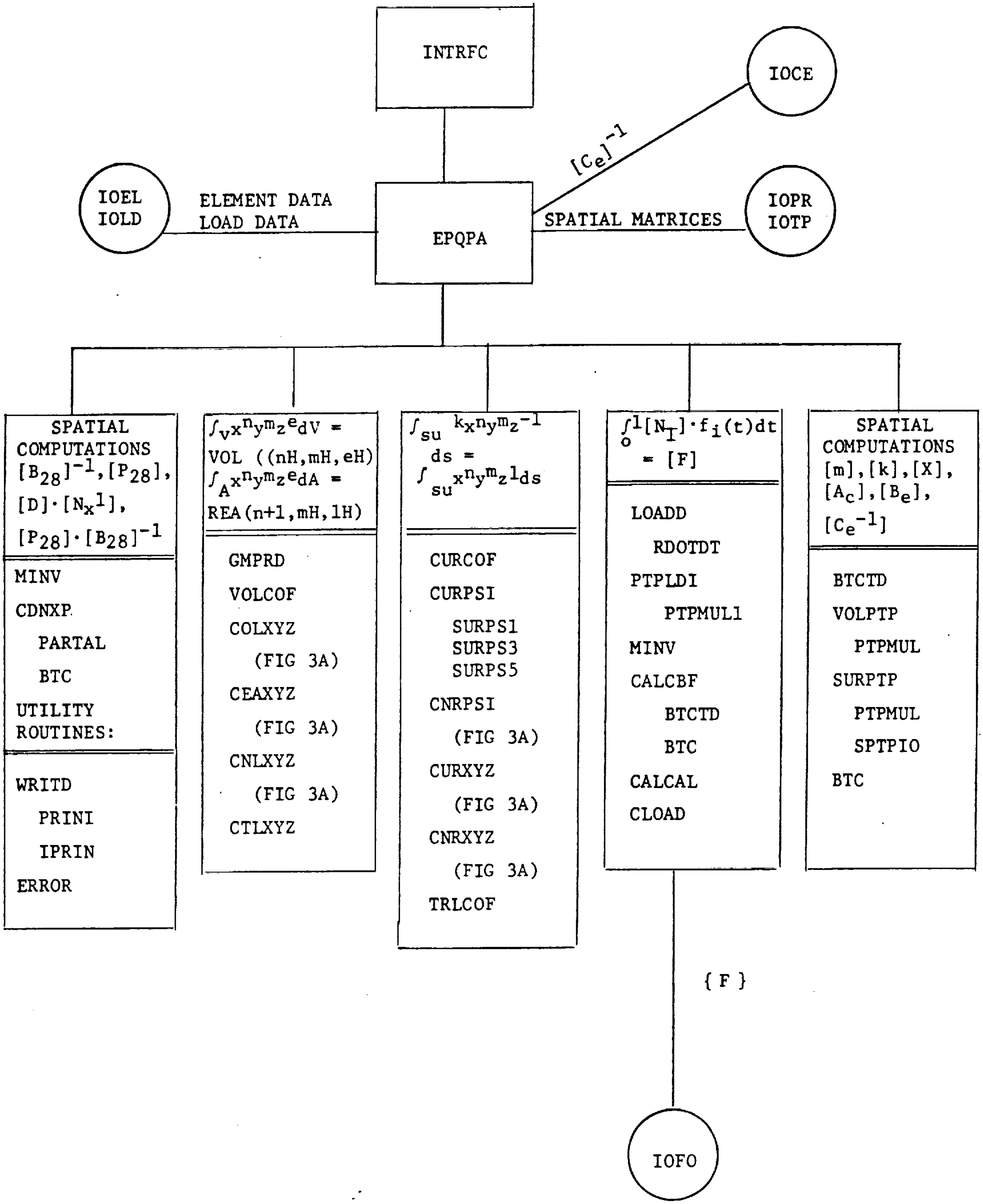

INTRFC
IOCE
$[C_e]^{-1}$
IOEL
IOLD
ELEMENT DATA
LOAD DATA
EPQPA
SPATIAL MATRICES
IOPR
IOTP
SPATIAL COMPUTATIONS $[B_{28}]^{-1}$, $[P_{28}]$, $[D]\cdot[N_x^1]$, $[P_{28}]\cdot[B_{28}]^{-1}$
MINV
CDNXP
PARTAL
BTC
UTILITY ROUTINES:
WRITD
PRINI
IPRIN
ERROR
$\int_V x^n y^m z^e dV$ = VOL ((nH,mH,eH)
$\int_A x^n y^m z^e dA$ = REA(n+1,mH,1H)
GMPRD
VOLCOF
COLXYZ
(FIG 3A)
CEAXYZ
(FIG 3A)
CNLXYZ
(FIG 3A)
CTLXYZ
$\int_{su} k_x n_y m_z^{-1} ds = \int_{su} x^n y^m z^1 ds$
CURCOF
CURPSI
SURPS1
SURPS3
SURPS5
CNRPSI
(FIG 3A)
CURXYZ
(FIG 3A)
CNRXYZ
(FIG 3A)
TRLCOF
$\int_0^1 [N_T]\cdot f_i(t)dt$ = [F]
LOADD
RDOTDT
PTPLDI
PTPMUL1
MINV
CALCBF
BTCTD
BTC
CALCAL
CLOAD
SPATIAL COMPUTATIONS [m],[k],[X], $[A_c]$,$[B_e]$, $[C_e^{-1}]$
BTCTD
VOLPTP
PTPMUL
SURPTP
PTPMUL
SPTPIO
BTC
{ F }
IOFO

FIGURE 3

| COLXYZ $\int_V x^n y^m z^l dV$ | CEAXYZ $\int_A x^n y^m z^l dA$ | CNLXYZ $\int_V x^n y^m z^l dV$ | CNRPSI $\int_{ds} p^k z^l dS$ | CURXYZ $\int_{ds} x^n y^m z^l dS$ | CNRXYZ $\int_{ds} n^n y^m z^l dS$ |
|---|---|---|---|---|---|
| VOL111 | REA111 | VOL181 | SURP1X | SURXY1 | SURX81 |
| VOL211 | REA211 | thru | SURPY1 | SURXY3 | SURX91 |
| VOL311 | REA311 | VOL011 | SUP53X | SURX13 | SURX01 |
| VOL411 | REA411 | (13 Rout) | SUP63X | SURX23 | SUR8Y1 |
| VOL511 | REA511 | | SUP73X | SURX33 | SUR9Y1 |
| VOL611 | REA611 | VOL183 | SUPY13 | SURX43 | SUR0Y1 |
| VOL711 | REA711 | thru | SUPY23 | SURX53 | SURX83 |
| VOL113 | REA113 | VL1043 | SUPY33 | SURX63 | SURX93 |
| VOL213 | REA213 | (32 Rout) | SUPY43 | SURX73 | SURX03 |
| VOL313 | REA313 | | SUP55X | SURXY5 | SUR8Y3 |
| VL313 | REA413 | VOL145 | SUP65X | SURX15 | SUR9Y3 |
| VL363 | RA413 | thru | SUP75X | SURX25 | SUR0Y3 |
| VOL413 | RA433 | VOL845 | SUP155 | SURX35 | SURX85 |
| VL413 | REA513 | (29 Rout) | SUP165 | SURX45 | SUR8Y5 |
| VL453 | RA513 | | SUP175 | SURX55 | SURX17 |
| VOL513 | RA553 | VOL117 | SUP255 | SURX65 | SURX27 |
| VL513 | REA613 | thru | SUP265 | SURX75 | SURX37 |
| VL543 | REA713 | VOL447 | SUP275 | | SURX47 |
| VL553 | | (4 Rout) | SUP355 | | |
| VOL613 | | | SUP365 | | |
| VOL713 | | | SUP375 | | |
| VL713 | | | SUP455 | | |
| VL733 | | | SUP465 | | |
| VOL115 | | | SUP475 | | |
| VOL215 | | | SURPS7 | | |
| VOL315 | | | | | |

FIGURE 3A

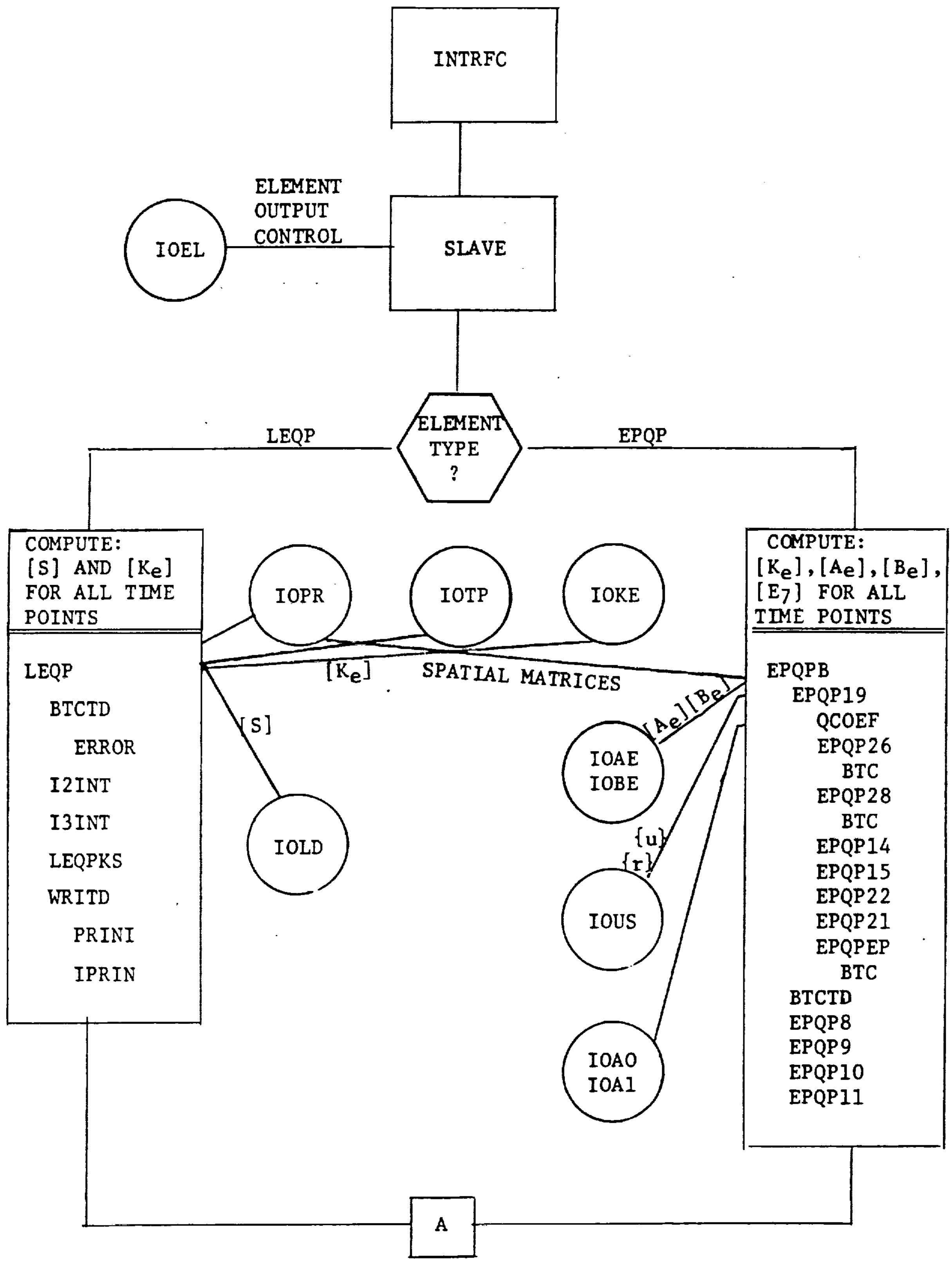

INTRFC
ELEMENT OUTPUT CONTROL
IOEL
SLAVE
ELEMENT TYPE ?
LEQP
EPQP
COMPUTE: [S] AND [Ke] FOR ALL TIME POINTS
LEQP
BTCTD
ERROR
I2INT
I3INT
LEQPKS
WRITD
PRINI
IPRIN
IOPR
IOTP
IOKE
[Ke]
SPATIAL MATRICES
[S]
IOLD
[Ae][Be]
IOAE
IOBE
{u}
{r}
IOUS
IOAO
IOA1
COMPUTE: [Ke],[Ae],[Be],[E7] FOR ALL TIME POINTS
EPQPB
EPQP19
QCOEF
EPQP26
BTC
EPQP28
BTC
EPQP14
EPQP15
EPQP22
EPQP21
EPQPEP
BTC
BTCTD
EPQP8
EPQP9
EPQP10
EPQP11
A

FIGURE 4

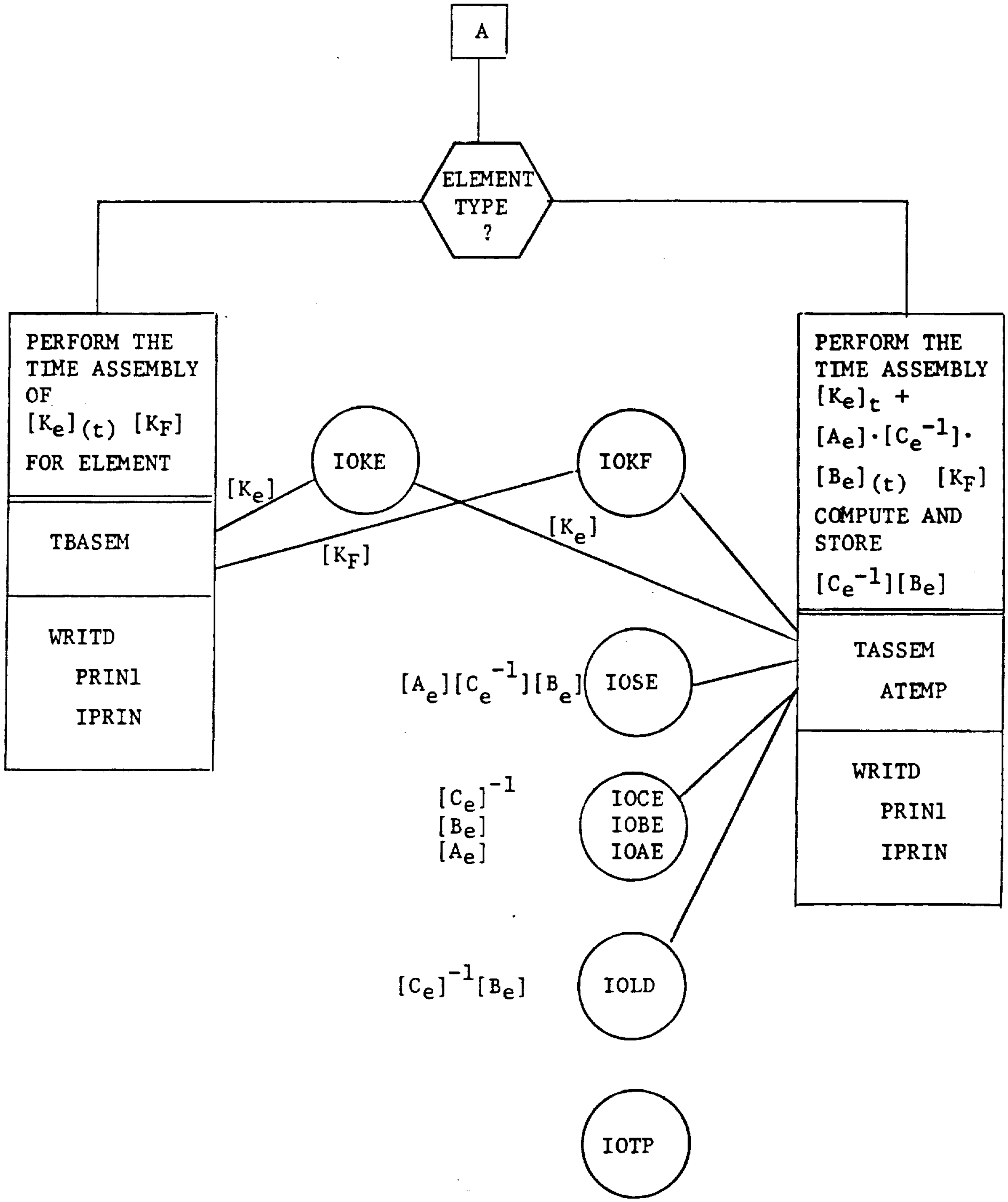



FIGURE 4 (Continued)

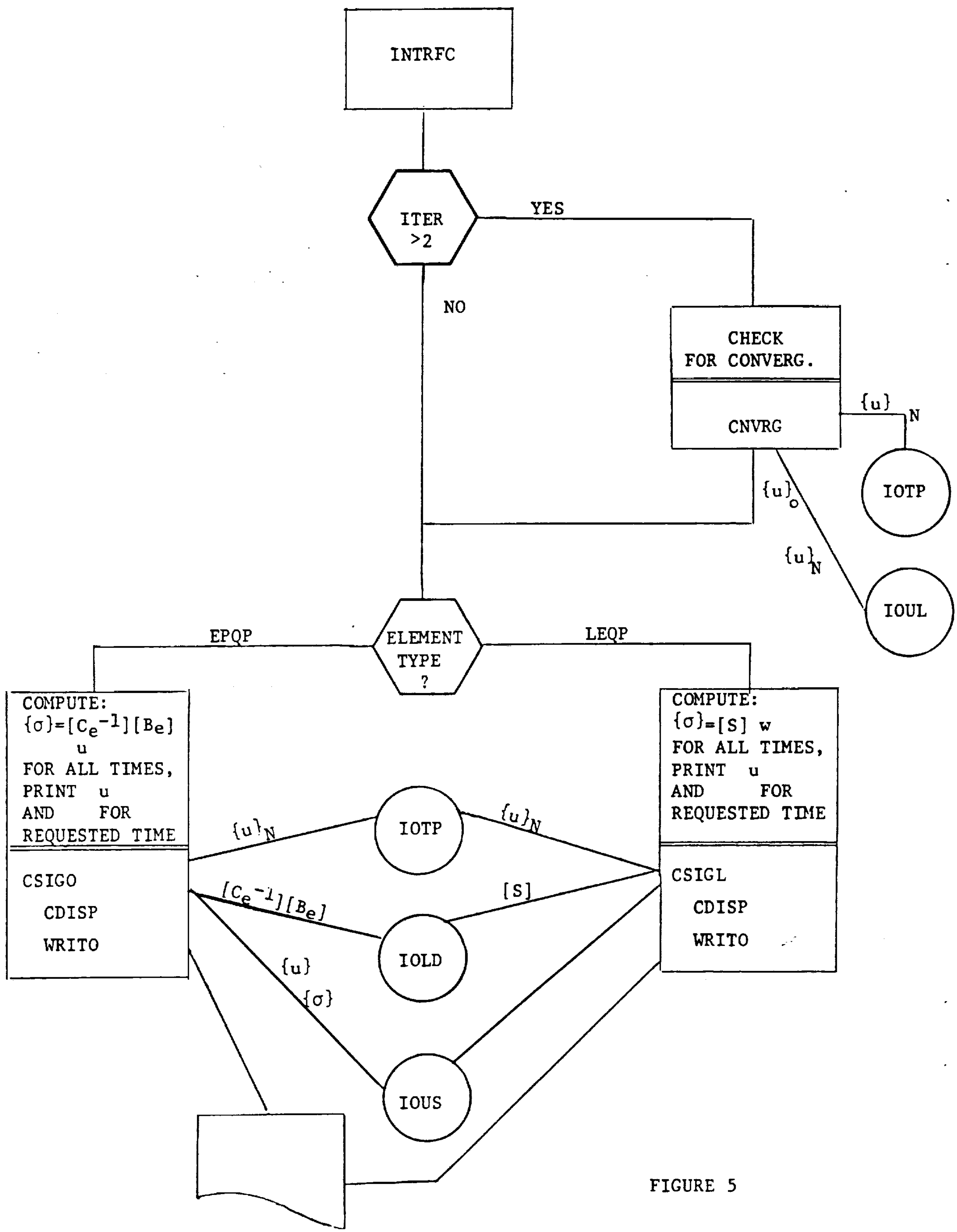

INTRFC
ITER
>2
YES
NO
CHECK
FOR CONVERG.
CNVRG
{u}
N
IOTP
{u}
o
{u}
N
IOUL
EPQP
ELEMENT
TYPE
?
LEQP
COMPUTE:
{σ}=[Ce-1][Be]
u
FOR ALL TIMES,
PRINT u
AND FOR
REQUESTED TIME
CSIGO
CDISP
WRITO
COMPUTE:
{σ}=[S] w
FOR ALL TIMES,
PRINT u
AND FOR
REQUESTED TIME
CSIGL
CDISP
WRITO
{u}N
IOTP
{u}N
[Ce-1][Be]
[S]
IOLD
{u}
{σ}
IOUS

FIGURE 5

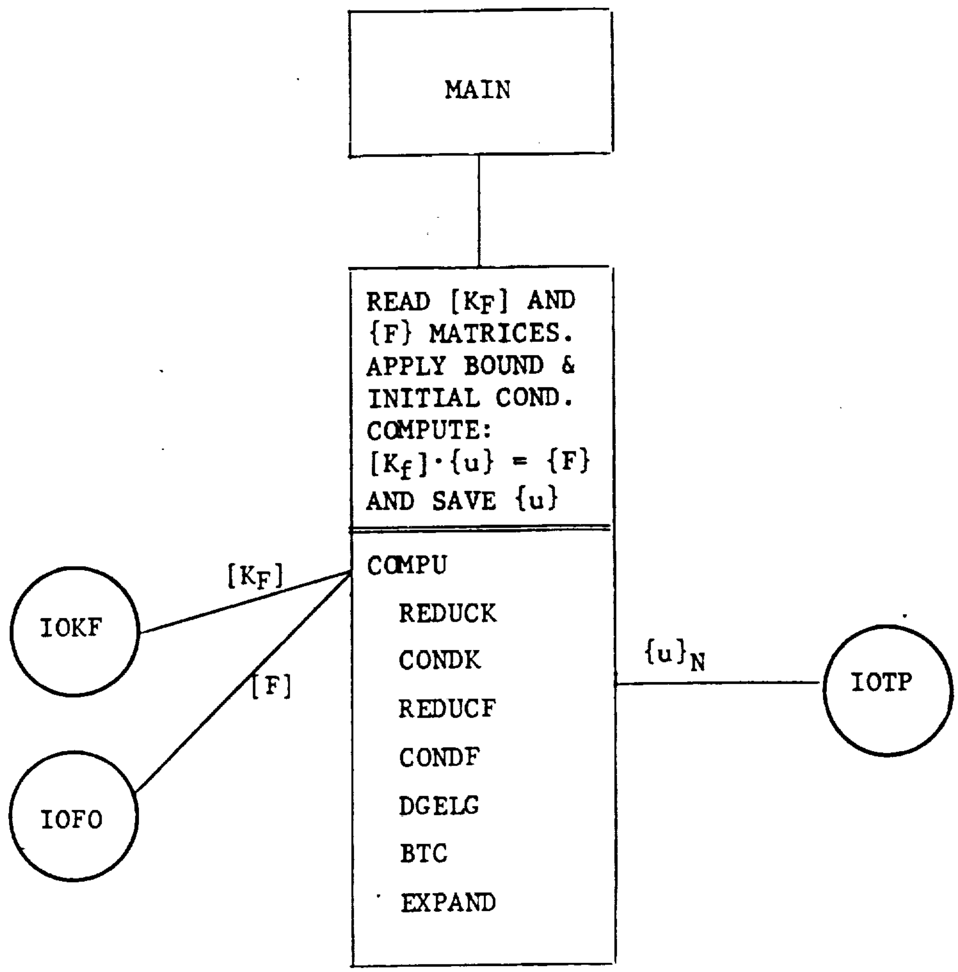

MAIN
READ [KF] AND {F} MATRICES. APPLY BOUND & INITIAL COND. COMPUTE: [Kf]·{u} = {F} AND SAVE {u}
COMPU
REDUCK
CONDK
REDUCF
CONDF
DGELG
BTC
EXPAND
IOKF
IOFO
IOTP
[KF]
[F]
{u}N

FIGURE 6

## 3.0 MATRIX DESCRIPTION AND LABELING

The basic matrices generated by the element computations consists of the $[K_F]$, $[S]$, and $\{F_F\}$ matrices. The matrices are stored on files "IOKF", "IOLD", and "IOFO" respectively. The basic matrices are illustrated in Figures 7 to 14 and are described as follows.

### 3.1 Stiffness $[K_F]$ Matrices

Figure 7 depicts the time assembled $[K_F]$ matrix for the EPQP element. Each numbered box represents a 168 by 168 partition and each partition is labeled from $T_0$ to $T_N$ (global time, were $T_0$=0.0). The numbering of the partitions signifies the order in which they are stored on the sequential file "IOKF". Similarly, Figure 8 depicts the time assembled $[K_F]$ matrix for the LEQP element. It should be noted that rows 1-84 of partition rows $T_0$ and $T_N$ are to be reduced from the matrix before using to solve for $\{u\}$. Finally, Figure 9 illustrates the labeling of each $K_F$ partition.

### 3.1.1 $[K_F]$ MATRIX LABELING

The $[K_F]$ matrix partitions are computed and time assembled ($K_F = K_e + [A_e][C_e^{-1}][B_e]$). The non-zero 168 by 168 $K_F$ partitions are stored on File IOKE. Figure 7 shows the $K_F$ matrix-partition labeling and order of storing on file IOKF for the EPQP element. Similarly, Figure 8 represent the $K_F$ matrix for the LEQP element. Figure 9 is a sketch of the labeling of each partition for both the EPQP and LEQP elements.

FIGURE 7: EPQP $[K_F]$ MATRIX PARTITIONS

| | $T_1$ | $T_2$ | $T_3$ | . | . | $T_{N-1}$ | $T_N$ |
|---|---|---|---|---|---|---|---|
| $T_0$ | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| $T_1$ | 2 | N+2 | 0 | 0 | 0 | 0 | 0 |
| $T_2$ | 3 | N+3 | 2(N+1) | 0 | 0 | 0 | 0 |
| $T_3$ | 4 | N+4 | 2(N+1) +1 | .. | 0 | 0 | 0 |
| . | . | . | . | . | . | 0 | 0 |
| . | . | . | . | .. | . | . | 0 |
| $T_{N-1}$ | N | 2(N+1) -2 | 3(N+1) -4 | .. | . | . | . |
| $T_N$ | N+1 | 2(N+1) -1 | 3(N+1) -3 | . | . | . | . |

$$=(N+1)(IC-1)+IR-\sum_{I=1}^{IC}(I-1)$$

$\left\{\begin{array}{l} IC = \text{COL. NO.} \\ IR = \text{ROW NO.} \\ N = \text{NTIME}-1 \end{array}\right\}$

where: $T_{(L)}$ = input global times

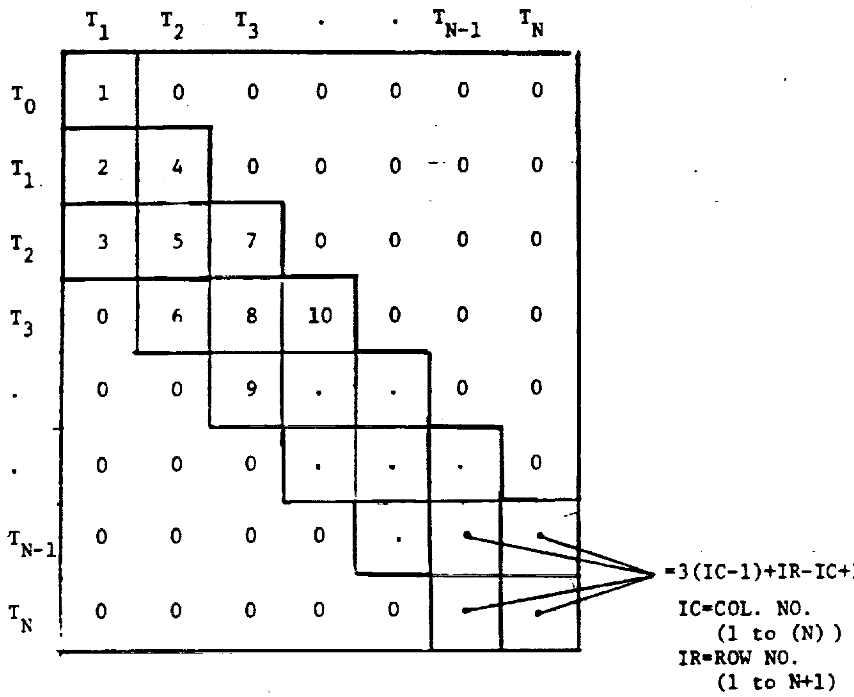
$T_0$ = 0.0

Note: 1) Matrix partition col. no. 1 contains time $T_1$ partitions

2) Partitions are output to file IOKF in the order they are numbered in diagram

3) Each partition is a 168 by 168 matrix, see Figure 9 for labeling of partitions.

FIGURE 8. LEQP [$K_F$] MATRIX PARTITIONS




Where: $T_{(i)}$ = Input global times

$T_0$ = 0.0

Note: 1) Partition matrix col. no. 1 contains time $T_1$ partitions

2) Partitions are output to file IOKF in the order they are numbered in diagram above

3) Each partition is a 168 by 168 matrix. See Figure 3 for labeling of partitions.

| | | x $U$ GRID 1-28 | x $V$ GRID 1-28 | x $W$ GRID 1-28 | x $\dot{U}$ GRID 1-28 | x $\dot{V}$ GRID 1-28 | x $\dot{W}$ GRID 1-28 |
|---|---|---|---|---|---|---|---|
| | $= F_U$ | GRID 1 ↓ 28 | | | | | |
| | $= F_V$ | GRID 1 ↓ 28 | | | | | |
| | $= F_W$ | GRID 1 ↓ 28 | | $[K_F]$ PARTITION 168 BY 168 | | | |
| $T_{(i)}$ | $= F_{\dot{U}}$ | GRID 1 ↓ 28 | | | | | |
| | $= F_{\dot{V}}$ | GRID 1 ↓ 28 | | | | | |
| | $= F_{\dot{W}}$ | GRID 1 ↓ 28 | | | | | |

NOTE: GRID NOD ARE LOCAL

FIGURE 9

### 3.2 Stress [S] Matrices (EPQP Element)

The equation to compute the six (6) stress components at the 28 element grid points for time interval J is:

$$\{\sigma\}_J = [C_\sigma^{-1}][B_o^{\,1}]\{u_o\} + \sum_{I=2}^{J} \left([C_\sigma^{-1}]\cdot([B_o^{\,I}] + [B_T^{\,(I-1)}])\cdot\{u_{(I-1)}\}\right) + [C_\sigma^{-1}][B_T^{\,J}]\{u_{(J)}\} - \sum_{I=1}^{J} \left([C_\sigma^{-1}]\{q_{(I)}\}\right) + \{\sigma_o\} \tag{1}$$

The time assembled resulting matrix equation, collecting like terms, could be represented as follows:

$$\underbrace{\begin{Bmatrix} \sigma_{(1)} \\ \sigma_{(2)} \\ \cdot \\ \cdot \\ \cdot \\ \sigma_{(N)} \end{Bmatrix}}_{(N\times 28\times 6)} = \underbrace{[S_1]}_{(N\cdot 168)\times(N+1)\cdot 168} \cdot \underbrace{\begin{Bmatrix} U_0 \\ U_1 \\ U_2 \\ \cdot \\ \cdot \\ U_N \end{Bmatrix}}_{(N+1)\cdot 168} - \underbrace{[S_2]}_{(N\cdot 168)\times(N\cdot 168)} \cdot \underbrace{\begin{Bmatrix} q\tau_1 \\ q\tau_2 \\ \cdot \\ \cdot \\ \cdot \\ q\tau_N \end{Bmatrix}}_{(n\cdot 168)} + \underbrace{\begin{Bmatrix} \sigma_o \\ \sigma_o \\ \cdot \\ \cdot \\ \cdot \\ \sigma_o \end{Bmatrix}}_{(N\cdot 168)}$$

Figure 10 illustrates the $[S_1]$ matrix which is computed in routine "TASSEM" and stored on file "IOLD" in 168 by 168 partitions. The number of each partition represents its location on the sequential output file "IOLD" as well as the terms of equation (1) above as listed below.

| PARTITION TYPE | CONTAINS |
|---|---|
| 1 | $[C_\sigma^{-1}]\cdot[B_o^{\,1}]$ |
| 2, 4, 6, ... (Nx2) | $[C_\sigma^{-1}]\cdot[B_T^{\,IR}]$; IR=1,N |
| 3, 5, 7, ... (Nx2)-1 | $[C_\sigma^{-1}]\cdot([B_o^{\,(IC+1)}]+[B_T^{\,IC}])$; IC=1,(N-1) |

Figure 11 illustrates the $[S_2]$ matrix. Matrix $[S_2]$ is simply the time assembled $-[C^1]^{-1}$ matrix where $[C^1]=^-[C_e]$ with the first column removed; i.e.,

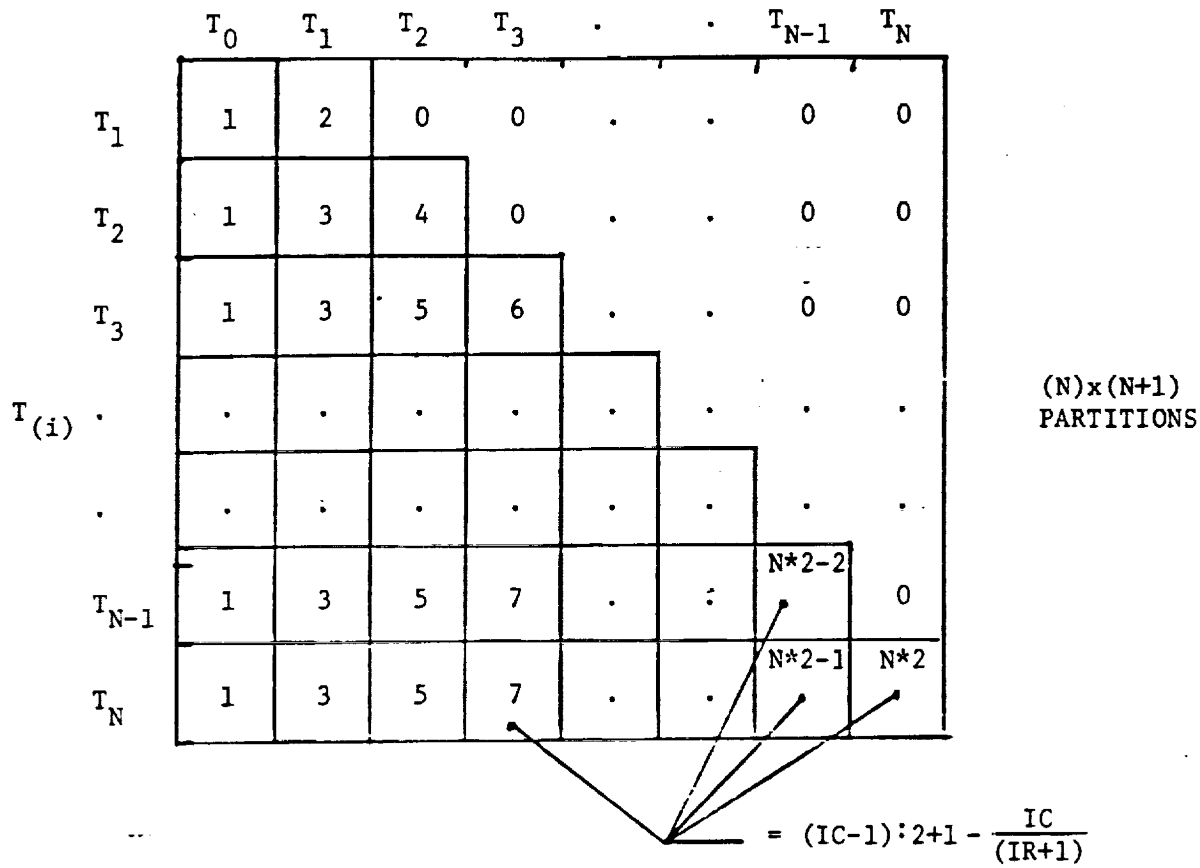
$$[C_e] = \begin{bmatrix} -[C_\sigma] & [C_\sigma] & 0 & . & . & . & 0 & 0 \\ 0 & -[C_\sigma] & [C_\sigma] & . & . & . & 0 & 0 \\ . & . & . & . & . & . & . & . \\ . & . & . & . & . & . & . & . \\ 0 & 0 & 0 & . & . & . & -[C_\sigma] & [C_\sigma] \end{bmatrix} (N \times (N+1))$$

$$[C^1] = \begin{bmatrix} [C_\sigma] & 0 & 0 & 0 & . & . & 0 & 0 \\ -[C_\sigma] & [C_\sigma] & 0 & 0 & . & . & 0 & 0 \\ 0 & -[C_\sigma] & [C_\sigma] & 0 & . & . & 0 & 0 \\ 0 & 0 & -[C_\sigma] & [C_\sigma] & . & . & 0 & 0 \\ . & . & . & . & . & . & . & . \\ . & . & . & . & . & . & . & . \\ 0 & 0 & 0 & 0 & . & . & -[C_\sigma] & [C_\sigma] \end{bmatrix} (N \times N)$$

File "IOCE" contains a 168 x 168 partition, $[C_\sigma^{-1}]$. The remaining variables namely, $\{w\}$, $\{q\}$, and $\{u_o/\sigma_o\}$ are stored on files "IOTP", "IOQT", and "IOUS" respectively.

Figure 12 contains a sketch of the partition labeling for both the $[S_1]$ and $[S_2]$ matrix partitions.

FIGURE 10. STRESS $[S_1]$ MATRIX




IC = Column Number

IR = Row Number

$T_{(\ )}$ = Input Global Times

$T_o$ = 0.0

NOTE:

1) Matrix partition row number 1 contains time $T_1$ partitions

2) Partitions are output to file "IOLD" in the order they are numbered in diagram

3) Each partition is a 168 x 168 matrix, see Figure 12 for labeling of partitions

FIGURE 11. STRESS $[S_2]$ MATRIX

$$
-[S_2] = \begin{array}{c}
 \\ T_1 \\ T_2 \\ T_3 \\ \cdot \\ \cdot \\ T_{N-1} \\ T_N
\end{array}
\begin{array}{ccccccc}
T_1 & T_2 & T_3 & \cdot & \cdot & T_{N-1} & T_N \\
\hline
-[C_\sigma^{-1}] & 0 & 0 & \cdot & \cdot & 0 & 0 \\
-[C_\sigma^{-1}] & -[C_\sigma^{-1}] & 0 & \cdot & \cdot & 0 & 0 \\
-[C_\sigma^{-1}] & -[C_\sigma^{-1}] & -[C_\sigma^{-1}] & \cdot & \cdot & 0 & 0 \\
\cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\
\cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\
-[C_\sigma^{-1}] & -[C_\sigma^{-1}] & -[C_\sigma^{-1}] & \cdot & \cdot & -[C_\sigma^{-1}] & \\
-[C_\sigma^{-1}] & -[C_\sigma^{-1}] & -[C_\sigma^{-1}] & \cdot & \cdot & -[C_\sigma^{-1}] & -[C_\sigma^{-1}]
\end{array}
\quad \begin{array}{l} \text{N X N} \\ \text{PARTITIONS} \end{array}
$$

NOTE:

1) Each partition is identical and the 168 x 168 matrix $[C_\sigma^{-1}]$ is stored on file "IOCE" by routine "EPQPA".

FIGURE 12. EPQP STRESS MATRIX PARTITION LABELING

| | | xU GRID 1-28 | xV GRID 1-28 | xW GRID 1-28 | $x\dot{U}$ GRID 1-28 | $x\dot{V}$ GRID 1-28 | $x\dot{W}$ GRID 1-28 |
|---|---|---|---|---|---|---|---|
| $T_{(i)}$ | = xx GRID 1-28 | $[S_1]/[S_2]$ PARTITION 168 X 168 | | | | | |
| | = yy GRID 1-28 | | | | | | |
| | = zz GRID 1-28 | | | | | | |
| | = xy GRID 1-28 | | | | | | |
| | = xz GRID 1-28 | | | | | | |
| | = yx GRID 1-28 | | | | | | |

Note: Grid Numbers are Local

$$\sigma_{GRID,6,t)} = [S_1] \cdot \{u_t\} - [S_2]\ \{q_t\} + \begin{Bmatrix} \sigma_o \\ \sigma_o \\ \sigma_o \\ \cdot \\ \cdot \\ \cdot \\ \sigma_o \end{Bmatrix}$$

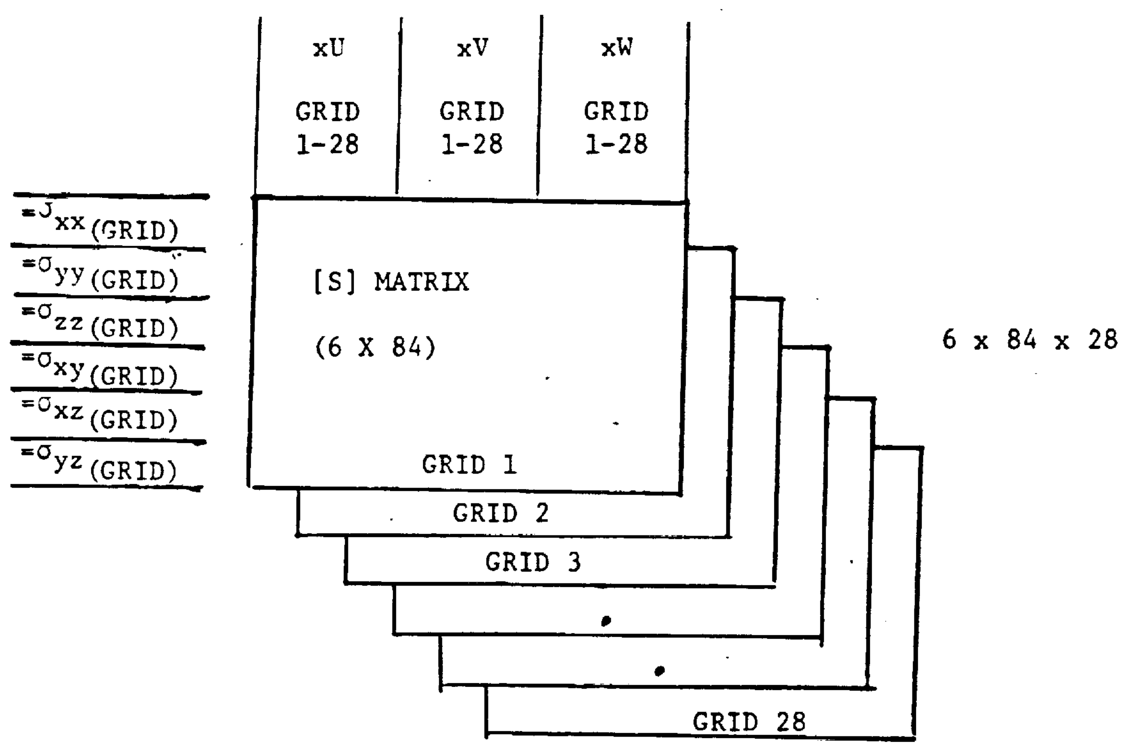
t=1-N  Nx (N+1) Partitions  t=0-N  NxN Partitions  t=1-N

### 3.3 Stress [S] Matrices (LEQP Element)

The 6 x 84 x 28 stress matrices for the LEQP element are generated in routine LEQP and stored on file "IOLD". The equation used to obtain [S] is $[S]=[E_6][N_x^1]_{(GRID)}$, where $[N_x^1]$ is evaluated at each of the 28 grid points of the quadrilateral plate. Figure 13 illustrates the labeling of [S]. Since [S] for the LEQP element is time independent, the same matrix is used for each time increment in the problem solution and the velocity terms of the {u} vector are not used in this solution.

FIGURE 13. LEQP STRESS MATRIX LABELING

FOR ALL TIME INCREMENTS




$$\sigma(6,\mathrm{GRID})_t = [\,S_{6X84}\,]_{(GRID)} \cdot \begin{Bmatrix} U_t \\ V_t \\ W_t \end{Bmatrix}_{84X1}$$

$$[S] = [E_6][N_x{}']_{(GRID)}$$

### 3.4 Element Force Vector $\{F_F\}$

Figure 14 illustrates the force vector labeling and the time assembly of the element load vectors. The equations to adjust the force vectors for known initial conditions are as follows:

$$\{F_{F(o)}\} = \{F_o{}^1\} - [K_{oo}{}^1]\ \{u_o\} - [A_o{}^1]\ \{\sigma_o\} \tag{1}$$

$$\{F_F(1)\} = \{F_o{}^2 + F_T{}^1\} - ([K_{To}{}^1] + [A_o{}^2][C_\sigma{}^{-1}][B_o{}^1])\ \{u_o\} - \tag{2}$$

$$([A_o{}^2] + [A_T{}^1])\ \{q_o\} + [A_o{}^2][C_\sigma{}^{-1}]\ \{q_1\}$$

If N=1 $\quad \{F_{F(1)}\} = \{F_{F(1)}\} - [A_T{}^1]\ [C_\sigma{}^{-1}]\ [B_o{}^1]\ \{u_o\}$

$$\underset{J=2,N}{\{F_{F(J)}\}} = \{F_o{}^{(J+1)} + F_T{}^J\} - ([A_o{}^{(J+1)}] + [A_T{}^J])\ [C_\sigma{}^{-1}]\ [B_o{}^1]\ \{u_o\} -$$

$$([A_o{}^{(J+1)}] + [A_T{}^J])\ \{\sigma_o\} +$$

$$\sum_{L=1}^{J-1} (([A_o{}^{(J+1)}] + [A_T{}^{(J)}])\ [C_\sigma{}^{-1}]\ \{q_L\} +$$

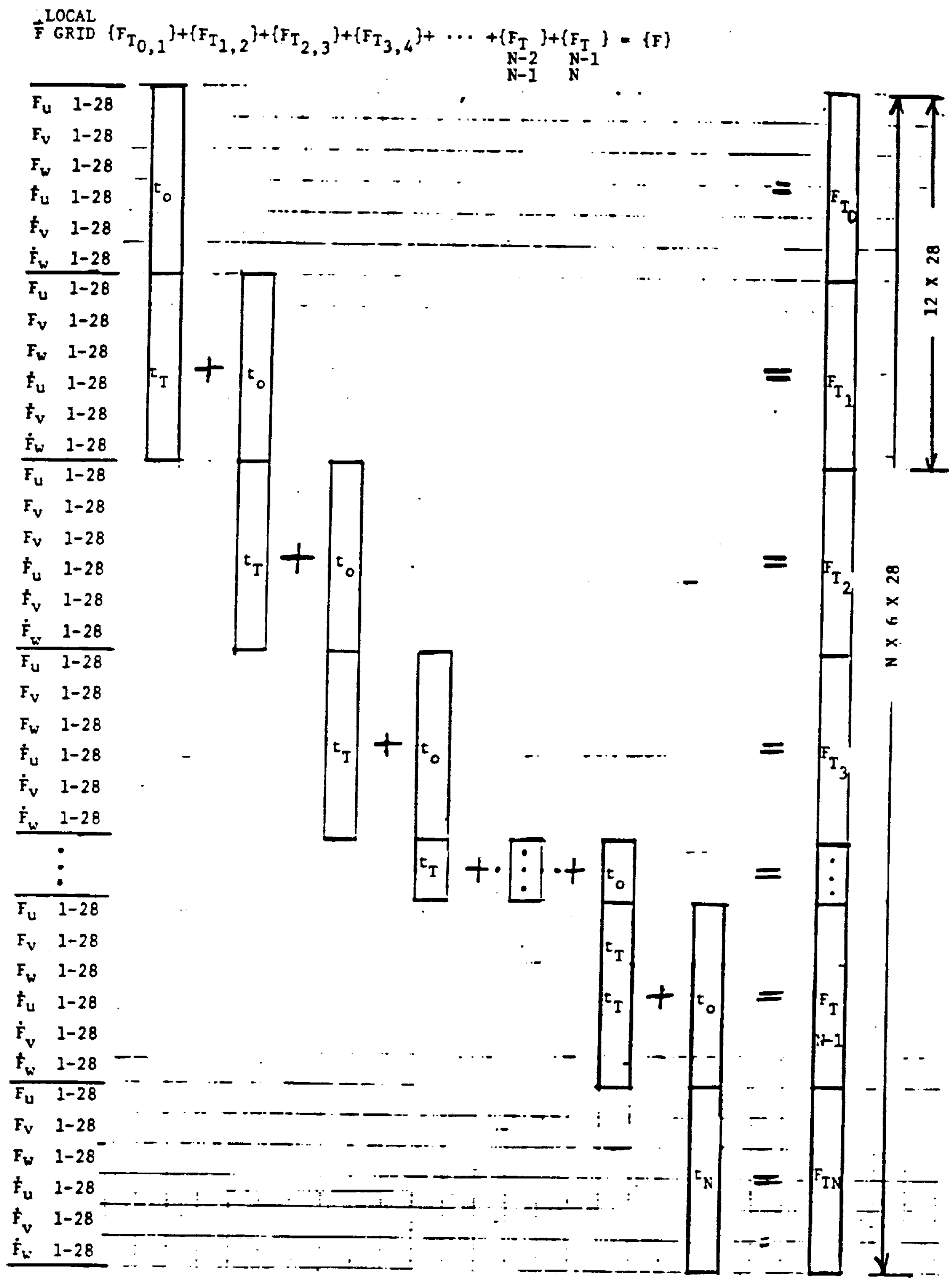
$$[A_o{}^{(J+1)}]\ [C_\sigma{}^{-1}]\{q_J\}$$

The first force vector is written to file IOFF[(1)] for solution of the problem $[K_F]\ \{u\} = \{F_F\}$.

NOTE:

(1) The above computations are not currently performed in the program. It is assumed that $\{u_o\} = \{\sigma_o\} = \{q\} = \{0\}$ and therefore file "IOFO" contains the $\{F_{OIT}{}^L\}$ vectors (unassembled). Routine "COMPU" currently preferring the time assembled.

FIGURE 14. {F} VECTOR TIME ASSEMBLY AND LABELING N=NTIME, $T_O$=0.0



## 4.0 EXTERNAL DATA SET STRUCTURE

The SFENES program uses 18 data sets during execution. The dataset variable unit names are stored in labeled common "IO" and are initialized to the integer unit number in routine "INTRFC". Table 1 contains the dataset names, default unit number, routines using the dataset and a brief description of the contents of each dataset. Table 2 lists the record descriptions and record formats contained in each dataset. All datasets contain binary output except "IOIN" and "I6". The binary datasets in several instances contain variable length records.

TABLE 1

| UNIT NAME | UNIT NO. | ROUTINE USING | IN/OUT | CONTENTS |
|---|---|---|---|---|
| IOLD | 1 (Binary) | INPUT | OUT | Element load codes and the computed or input force tables. This data is destroyed after total element load vectors are computed. |
| | | EPQPA | IN | |
| | | RDOTDT | IN | |
| | | LEQP | OUT | Element stress matrix (LEQP element) |
| | | CSIGL | IN | |
| | | ATEMP | OUT | Element matrix computation $[C_e]^{-1} \cdot [B_e]$ - (EPQP Stress Computation) results |
| IOEL | 2 (Binary) | INPUT | OUT | The element input data (name, local coordinates, material properties, load codes) |
| | | SLAVE | IN | |
| IOUS | 3 (Binary) | INPUT | OUT | The element stress component values, displacement and velocity values at each time increment and grid point [S], [U] |
| | | EPQP19 | IN | |
| | | CSIGL | IN/OUT | |
| | | CSIGO | IN/OUT | |
| IOIN | 5 (Formatted) | INPUT | IN | User element input data - load, material prop., titles, times, initial conditions |
| | | LOADIN | IN | |
| IOQT | 4 | | | Not Used |
| I6 | 6 (Formatted) | CSIGL | OUT | Printed output file (133 character records) |
| | | CSIGO | OUT | |
| | | ERROR | OUT | |
| | | INPUT | OUT | |
| | | IPRIN | OUT | |
| | | PRINI | OUT | |
| | | WRITD | OUT | |

TABLE 1 (CONTINUED)

| UNIT NAME | UNIT NO. | ROUTINE USING | IN/OUT | CONTENTS |
|---|---|---|---|---|
| IOPR | 7 (Binary) | EPQPA<br>EPQPB<br>LEQP | OUT<br>IN<br>IN | Spatial computations and integration results<br>$[B_{28}]^{-1}$, $[D] \cdot [N_x 1]$, $[P_{28}] \cdot [B_{28}]^{-1}$,<br>$[P_{28}]$, $[m]$, $\int_v [N_x 1] \cdot [N_x 1]\, dv$,<br>$\int_{sv} ([N_x^B]^T - [N_x\ ]^T) \cdot [\ ] \cdot [N_x^1]\, ds$,<br>$\int_v [N^1]^T \cdot [N^x]\, dV + \int_{sv} ([N^8]^T -$<br>$[N]^T) [\ ] [N_j^x]_c$<br>$\int_v [N^x]^T \cdot [N^1]\, dv$ – Permanent |
| IOTP | 8 (Binary) | EPQPA<br>EPQPB<br>LEQP | OUT<br>IN/OUT<br>IN/OUT | Temporary work file containing a copy of IOPR |
| | | ATEMP | IN/OUT | Temporary work file containing a copy of $[A_e]$ matrix |
| | | COMPU<br>CSIGL<br>CSIGO | OUT<br>IN<br>IN | Temporary work file containing the computed $\{u\}$ vector for all major time increments |
| IOCE | 9 (Binary) | EPQPA<br>ATEMP | OUT | Contains matrix $[C_e]^{-1}$ |
| IOKE | 10 (Binary) | EPQPB<br>TASSEM<br>LEQP<br>TBASEM | OUT<br>IN<br>OUT<br>IN | Element $[K_e]$ matrix for each time increment |

TABLE 1 (CONTINUED)

| UNIT NAME | UNIT NO. | ROUTINE USING | IN/OUT | CONTENTS |
|---|---|---|---|---|
| IOAE | 11 (Binary) | EPQPB<br>ATEMP | OUT<br>IN | Element $[A_e]$ matrix partitions for each increment |
| IOBE | 12 (Binary) | EPQPB<br>ATEMP | OUT<br>IN | Element $[B_e]$ matrix partitions for each increment |
| IOA1<br>IOA0 | 13<br>14<br>(Binary) | QCOEF<br>EPQP19 | OUT<br>IN | Contains coefficient arrays used to compute the [E7] matrices for each element time increment. One contains previous, the other current coefficients. |
| IOFO | 15 (Binary) | LOADD<br>COMPU | OUT<br>IN | Integrated element force data for each grid and time point {F} |
| IOKF | 16 (Binary) | TASSEM<br>TBASEM<br>COMPU | OUT<br>OUT<br>IN | Contains the temporaly assembled [KF] matrix |
| IOSE | 17 (Binary) | ATEMP<br>TASSEM | OUT<br>IN | Temporary storage of the $[A_e]$ $[C_e^{-1}]$ $[B_e]$ computation |
| IOUL | 18 (Binary) | CNVRG | IN/OUT | The resulting displacement and velocities from the previous iterations solution. Saved for comparison to the results of the next iteration. |

| FILE NAME | RECORD DESCRIPTION | RECORD FORMAT |
|---|---|---|
| IOLD (Load Data) | 1 Element Load Code | ((LCODE(I,J),I=1,7),J=1,6) 42 integers/record |
| | 2 Element forces at NGRID affected grids for this load type and for D.O.F. u,v,w | ((FVO(I,J),J=1,NGRID),I=1,3) NGRID = 10, 12, or 28 ∴ 30, 36 or 84 real data/record |
| | 3 If ID=2 only element rate of force at NGRID affected grids for this lead type and D.O.F. u,v,w - | ((FVT(I,J),J=1,NGRID),I=1,3) NGRID = 10, 12 or 28 :30, 36, or 84 real data/record |
| | NOTE: Records (2) or (2 and 3) are repeated for each input load type and for each time point. | |
| | The data is overwritten by: | |
| (LEQP Stress Matrix) | 1 Element stress matrix 6 components, computed from 84 displacement D.O.F. for all 28 grids | (((STRM(I,J,K),I=1,6),J=1,84), K=1,28) 14112 real data/record |
| | or by: | |
| (EPQP Stress Matrices $[C_e]^{-1}\cdot[B_e]$ | 1 Element stress matrix partition $[C\ ]^{-1}([B_o]^N + [B_T]^{N-1})$ | ((DOT(I,J),I=1,168),J=1,168) 28224 real data/record |
| | 2 Element stress matrix partition $[C\ ]^{-1}\cdot[B_T]^N$ | ((DT(I,J),I=1,168),J=1,168) 28284 real data/record |
| | NOTE: Records 1 and 2 are repeated (NTIME-1) times (N=1, (NTIME-1)) | |
| IOEL (Element Input Data) | 1 Element name and code | ANAM, NELEM 21 real and 1 integer/record |
| | 2 Element local coord., material prop., and load codes | (X(I),Z(I)=1,28), (H(J),J=1,4), RHO, AMU, ALPHA, NU, E, YSTR, AJ, (ILOAD(T),I=1,7), NONLIN 94 real and 9 integer data items/record |

TABLE 2

| FILE NAME | RECORD DESCRIPTION | RECORD FORMAT |
|---|---|---|
| IOUS (Element Input Data) | 1<br>Element stress components (6 each) for 28 grid poin points | ((SIG(I,J),I=1,28),J=1,6)<br>168 real data/record |
| | 2<br>Element disp-vel. components $(u,v,w,\dot{u},\dot{v},\dot{w})$ for 28 grid points | ((U1(I,J),I=1,28),J=1,6)<br>168 real data/record |
| | NOTE: Records 1 and 2 are repeated NTIME times | |
| IOIN (Element Input Formatted) | Several | See User Input Description |
| IOPR (Spatial Computation Data) | 1<br>The $[B_{28}]^{-1}$ matrix | ((B28(I,J),I=1,28),J=1,28)<br>784 real data/record |
| | 2<br>The $[D]\cdot[N_x']$ computation for all 28 grid points | (((DNXPP(I,J,K),I=1,7),J=1,84),K=1,28)<br>16414 real data/record |
| | 3<br>The $\{P_{28}\}\cdot[B_{28}]^{-1}$ computation for 28 grids | ((SIGNX(I,J),I=1,28),J=1,28)<br>784 real data/record<br>I=polynomial terms 1-28<br>J=grids 1-28 |
| | 4<br>The evaluation of $\{P_{28}\}$ for 28 grids | ((P28(I,J),I=1,28), J+1,28)<br>784 real data/record<br>I=polynomial terms 1-28<br>J=grids 1-28 |
| | 5<br>The mass computation $[B_{28}^{-1}]^T\cdot[\int_V P_{28}^T\cdot P_{28}dV]\cdot[B_{28}^{-1}]$ | ((CUUM(I,J),I=1,28),J=1,28)<br>784 real data/record |
| | 6<br>The [K] computation $[B_{28}^{-1}]^T\cdot[\int_V P_{28}(L)\cdot P_I^T\cdot P_j dV]\cdot[B_{28}^{-1}]$ | (((CIJK(M,N,K,),M=1,28),N=1,28),K=1,9)<br>7056 real data/record |

NOTE: Record 6 is repeated NLIN TIMES and L=1, NLIN:
for LEQP NLIN=1
for EPQP NLIN=28

Table 2 (Continued)

| FILE NAME | RECORD DESCRIPTION | RECORD FORMAT |
|---|---|---|
| IOPR (Cont.) | Record: NLIN + 6<br>The [X] computation – | (((CIJXE(M,N,K),M=1,28),N=1,28), K=1,6)<br>4704 real data/record |

$$\left\{ \left( \sum_{J=1}^{4} (([B_{10}^{-1}(J)]^{T} \cdot [\int_{s} P_{28}(L)\cdot P_{10}^{T}(J)\cdot P_{I}\,ds] - [B_{28}^{-1}]^{T}\cdot [\int_{s} P_{28}(L)\cdot P_{28}^{T}(J)\cdot P_{I}\,dS])\cdot ANG(K,J))\right)\cdot [B_{28}^{-1}] \right\}$$

| | | | | | | |
|---|---|---|---|---|---|---|
| K = | 1 | 2 | 3 | 4 | 5 | 6 |
| I = | x | y | z | x | y | z |
| ANG(K,J) = | SIN | SIN | SIN | COS | COS | COS |

NOTE: Record is repeated NLIN Times and L=1, NLIN;
For LEQP, NLIN=1
For EPQP, NLIN=28

| RECORD DESCRIPTION | RECORD FORMAT |
|---|---|
| Record: 2*NLIN+6<br>The $[A_e]$ spatial computations – EPQP only | (((CIJA(M,N,K),M=1,28),N=1,28),K=1,3)<br>2352 real data/record |

$$\left\{ \left( [B_{28}^{-1}]^{T}\cdot [\int_{v} P_{I}^{T}\cdot P_{28}\,dV] + \sum_{J=1}^{4} ((B_{10}^{-1}(J)]^{T}\cdot [\int_{su} P_{10(J)}^{T}\cdot P_{28(J)}\,dS] - [B_{28}^{-1}]^{T}\cdot [\int_{su} P_{28(J)}^{T}\cdot P_{28(J)}\,dS])\cdot ANG(K,J))\right)\cdot [B_{28}^{-1}] \right\}$$

| | | | |
|---|---|---|---|
| K = | 1 | 2 | 3 |
| I = | x | y | z |
| ANG(K,J) = | SIN | COS | 0.0 |

| RECORD DESCRIPTION | RECORD FORMAT |
|---|---|
| Record: 2*NLIN+7<br>The $[B_e]$ spatial computations – EPQP only | (((CIJA(M,N,K),M=1,28),N=1,28,K=1,3) |

$$\left\{ [B_{28}^{-1}]^{T}\cdot [\int_{v} P_{28}(L)\cdot P_{28}^{T}\cdot P_{I}\,dV]\cdot [B_{28}^{-1}] \right\}$$

| | | | |
|---|---|---|---|
| K = | 1 | 2 | 3 |
| I = | x | y | z |

Note: Record is repeated NLIN times and L=1, NLIN;
For LEQP NLIN=1
For EPQP NLIN=28

Table 2 (Continued)

| FILE NAME | RECORD DESCRIPTION | RECORD FORMAT |
|---|---|---|
| IOTP Temporary Storage) | Same as File IOPR | |
| | - or - | |
| | Record 1 - EPQP only $[A_o]^N$ partition of $[A_e]$ matrix | ((ABIN(I,J),I=1,168),J=1,168)<br>28224 real data/record |
| | Record 2 - $[A_T]^N$ partition of $[A_e]$ matrix | ((ABIN(I,J),I=1,168),J=1,168)<br>28224 real data/record |
| | NOTE: Records 1 and 2 are repeated NTIME times | |
| | - or - | |
| | Record 1 Displacement Vector {u} | (U1(K,I),K=1,168)<br>168 real data/record |
| | NOTE: Record is repeated for I=2, NTIME | |
| IOCE ($[C_e^{-1}]$ Matrix) | Record 1 - EPQP Only $[C_e^{-1}]$ matrix | ((CE(I,J),I=1,168),J=1,168<br>28224 real data/record |
| IOKE ($[K_e]$ Matrix) | Record 1 $[K_e]$ matrix partition | ((AKE(I,T),I-1,336),J=1,336)<br>112896 real data/record |
| | NOTE: Record is repeated (NTIME-1) times | |
| IOAE ($[A_e]$ Matrix) | Record 1 - EPQP Only $[A_o]^N$ partition of $[A_e]$ matrix | ((AE(I,J),I=1,168),J=1,168)<br>28224 real data/record |
| | Record 2 $[A_T]^N$ partition of $[A_e]$ | ((AE(I,J),I=169,336),J=1,168)<br>28224 real data/record |
| | NOTE: Records 1 and 2 are repeated (NTIME-1) times | |
| IOBE ($[B_e]$ Matrix) | Record 1 - EPQP Only $[B_o]^N$ partition of $[B_e]$ | ((BE1(I,J),I=1,168),J=1,168) |
| | Record 2 $[B_7]^N$ partition of $[B_e]$ | ((BE2(I,J),I=1,168),J-1,168) |
| | NOTE: Records 1 and 2 are repeated (NTIME-1) times | |

Table 2 (Continued)

| FILE NAME | RECORD DESCRIPTION | RECORD FORMAT |
|---|---|---|
| IOA1<br>IOA0<br>($E_7$ Coeff Arrays) | Record 1 - EPQP Only<br>Arrays AC, AT1, AT2, AT3, AT4, All (7, 7, 28, 4)<br><br>NOTE: Record is repeated (NTIMES-1) times | (AC, AT1, AT2, AT3, AT4)<br>All dimensioned (7, 7, 28, 4)<br>27440 real data/record |
| IOFO<br>(Integ. Force Vector) | Record 1<br>Vector {F}<br><br>NOTE: Record is repeated (NTIME-1) times | (((VLOAD(I,J,K),I=1,28),J=1,3), K-1,4)<br>336 real data/record<br>I=GRID, J=D.O.F. (u,v,w,)<br>K=0, 0, T, T |
| IOKF<br>($[K_F]$ Matrix) | Record 1<br>Partition (M,N) of the $[K_F]$ matrix<br><br>NOTE: Record repeated ( $\sum_{I=1}^{NTIME}$ (NTIME - (I-1))-1 times | ((ACB(I,J),I=1,168),J=1,168)<br>28224 real data record |
| IOSE<br>($[A_e] \cdot [C_e]^{-1} \cdot [B_e]$) | Record 1 - EPQP Only<br>Partition (M,N) of $[A_e]\cdot[C_e^{-1}]\cdot[B_e]$<br><br>NOTE: Record repeated ( $\sum_{I=1}^{NTIME}$ (NTIME-I))-1 times | ((ACB(I,J),I=1,168)J=1,168)<br>28224 real data/record |
| IOUL<br>($u, v, w, \dot{u}, \dot{v}, \dot{w}$) | Record 1<br>Displacement/velcoity vector from the previous iteration {u}<br><br>NOTE: Record is repeated for J=2, NTIME | (UNEW(I,J),I=1,168 |

Table 2 (Continued)

# SLAVE FINITE ELEMENT FOR

# NONLINEAR ANALYSIS OF ENGINE STRUCTURES

# USER'S MANUAL

## I.0 INTRODUCTION

The purpose of the SFENES program is to provide the user with validation of the basic matrices needed to compute the transient displacements of a group of non-linear elements and to provide for element stress recovery unpon convergence of the problem. In addition, the element matrices routines have been provided to compute resultant displacements, checks for convergence, output displacement and stress and perform element stress recovery. The program is limited by the following factors:

1. The only element currently provided is the quadrilateral plate element with either linear elastic analysis or non-linear elastic-plastic analysis.
2. Only a single structural element may be analyzed (multiple time intervals).
3. All input and output is in terms of the "local" coordinate system.
4. A maximum of 25 time points (solution times) may be requested. Output displacement times are unlimited.

The following pages describe the program and its input/output features.

## 2.0 SFENES OVERVIEW

The Slave Finite Element procedure is described here. Reference to Figure 1 will aid in the description of the solution algorithm. The element input data is interpreted and stored for later reference. All of the required spatial definite integrals are computed and stored as is the one time computation of the $[C]^{-1}$ matrix. The input element lead data (if any) is combined and integrated over the time intervals. The force vector {F} is then stored for later use in computation of {u}.

The iterative procedure starts with the computation of the matrices $[K_e]$ and either $[A_e]$, $[B_e]$ for the EPQP case or $[S_e]$ for the LEQP case. For the EPQP case the initial iteration assumes that the structural element is elastic for all time intervals but for each subsequent iteration the elastic and/or plastic regions are computed. The structural matrices are then assembled for global time. For the EPQP case final time assembled $[K_F]$ matrix is computed as $[K_F] = [K_e] = [A_c]\ [C_e]^{-1}\ [B_e]$ and the matrix multiplication $[C_e]^{-1}\ [B_e]$ is stored for later stress computation. The linear LEQP case simply involves the time assembly of each of the $[K_e]$ matrices as computed over the specified local time intervals. The $[K_F]$ matrix and the {F} vectors are then reduced based upon the input boundary conditions as well as the removal of the tows corresponding to displacements at times $T_0$ and $T_N$ (rows 1-84) and rows ((N*168)+1 to (N*168)+84) where N = the number of input time points minus 1 (1<N<24). The reduced $[K_F]$ matrix and {F} vector are used to compute the new

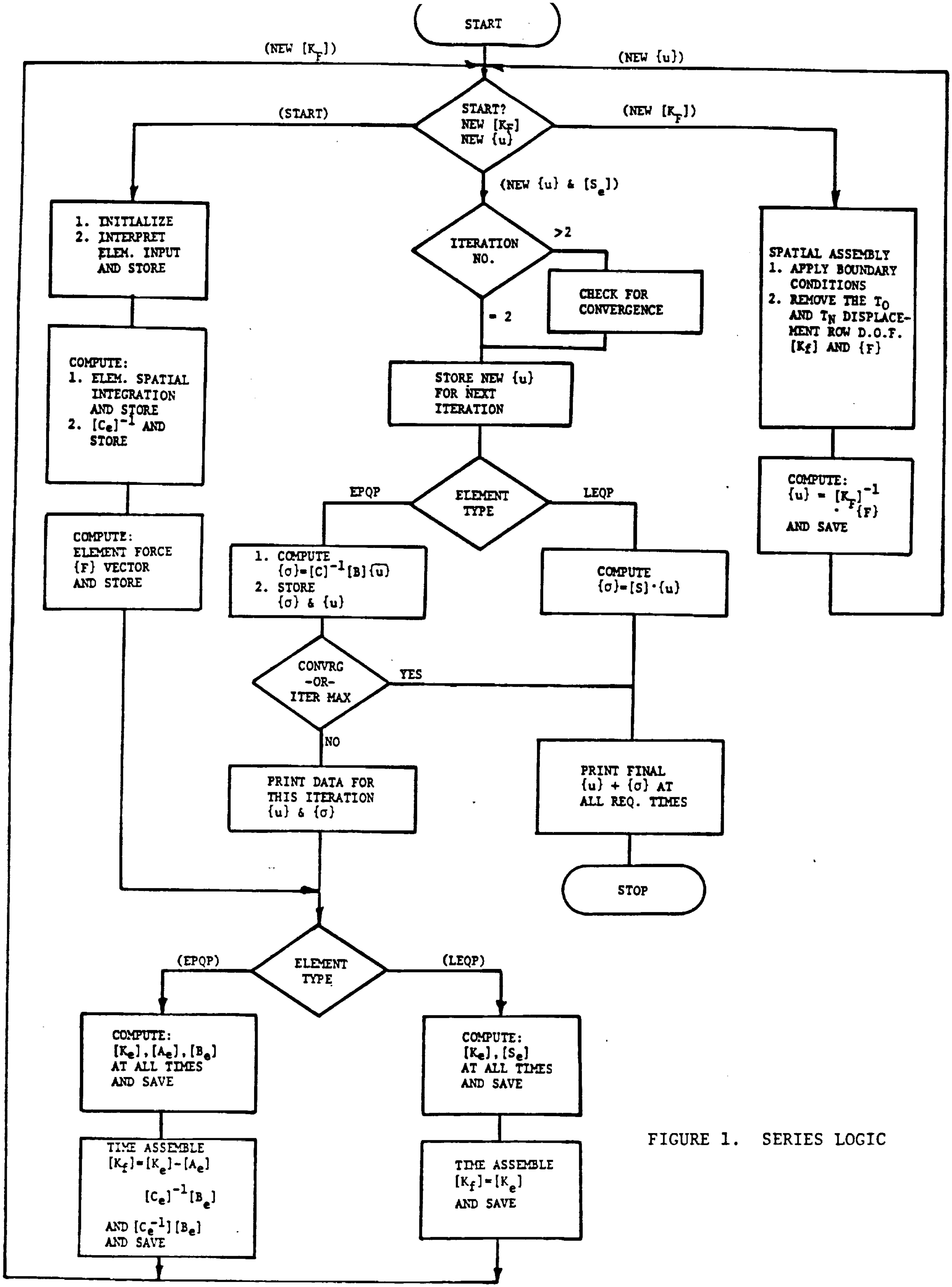


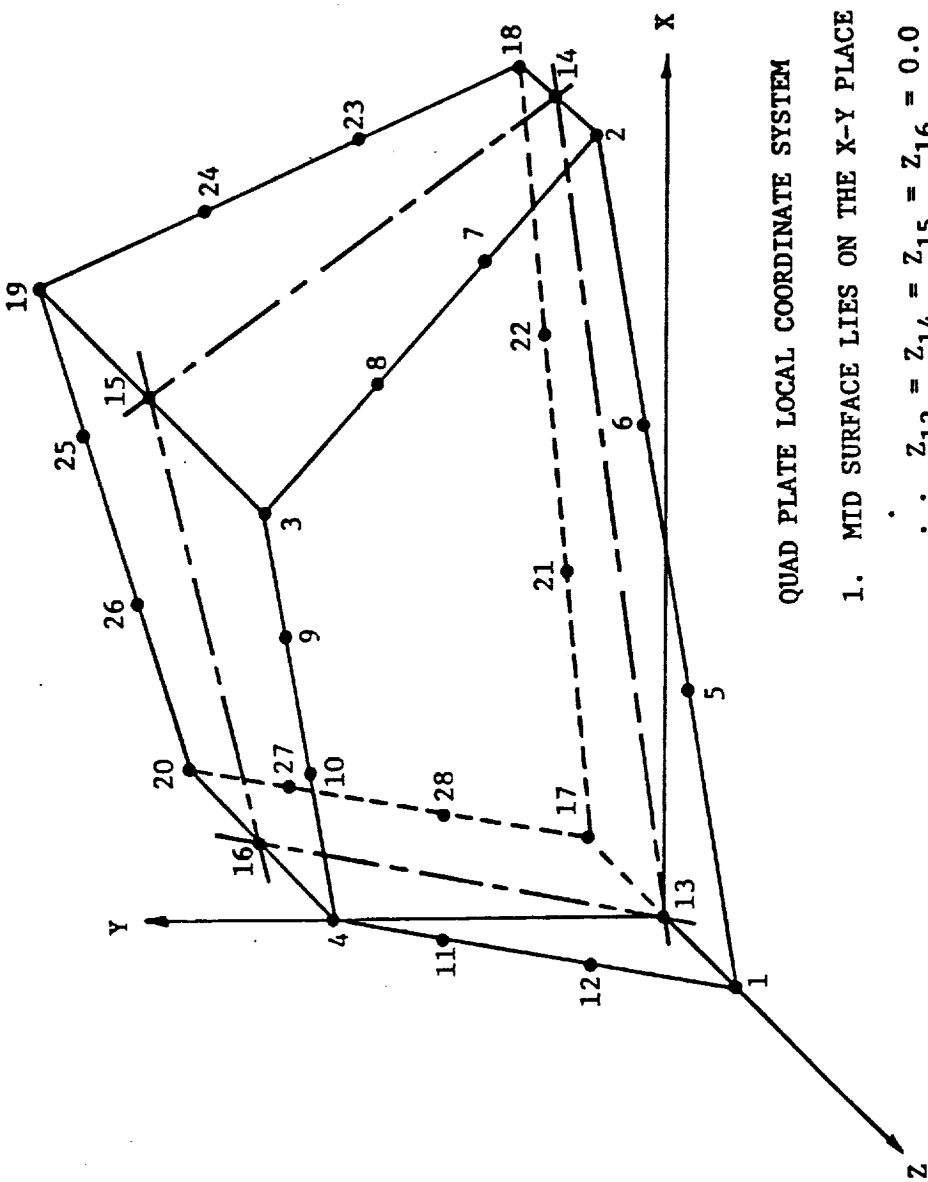

FIGURE 1. SERIES LOGIC

$\{u\}$ vector ($[K_F]\ \{u\} = \{F\}$). The updated value of $\{u\}$ is checked for convergence and then stored for the next iteration.

The vector $\{u\}$ and the stress matrices $[C_e]^{-1}\ [B_e]$ or $[S_e]$ are used to compute the stress vector $\{\sigma\} = [C_e]^{-1}\ [Be_e]\ \{u\}$ or $\{\sigma\}=[S_e]\ \{u\}$. The displacement and stress vectors are then stored for use in computation of the $[E_7]$ matrices for the next iteration. After each iteration the displacement and stresses are printed for the input time intervals only. When the problem converges the displacements are also printed at the requested output interval. The iterative procedure continues until convergence or maximum iteration is achieved.

## 3.0 QUADRILATERAL PLATE DESCRIPTION

One finite element is provided in SFENES and that is the quadrilateral plate element. Figure 2 depicts the local coordinate grid labeling and the orientation requirements. The analysis procedure permits transient analysis of the plate as either a linear elastic element (LEQP) or as a non-linear elastic-plastic element (EPQP).




QUAD PLATE LOCAL COORDINATE SYSTEM

1. MID SURFACE LIES ON THE X-Y PLACE

   $\therefore Z_{13} = Z_{14} = Z_{15} = Z_{16} = 0.0$

2. GRID POINT 13 AT LOCAL ORIGIN

   $X_{13} = Y_{13} = Z_{13} = 0.0$

$X_1=X_{13}=X_{17}$, $Y_1=Y_{13}=Y_{17}$, $X_2=X_{14}=X_{18}$, $Y_2=Y_{14}=Y_{18}$,

$X_3=X_{15}=X_{19}$, $Y_2=Y_{15}=Y_{19}$, $X_4=X_{16}=X_{20}$, $Y_4=Y_{16}=Y_{20}$

FIGURE 2. QUADRILATERAL PLATE LOCAL GRID IDENTIFICATION

## 4.0 INPUT OVERVIEW

The input requirements and options are described below. The following general rules must be observed.

1. Each input line consists of 8 fields of 10 characters each. In some cases a field is subdivided for integer or alpha input.
2. Integer data and floating point "E" format data must be right justified in their respective input fields.
3. One of the material prop inputs is required.

Listed below is a brief summary of the input options and notes regarding order and required usage.

| | |
|---|---|
| TITLE | Title information |
| TIME | (Required and must preceed and load input) The number of time increments +1 and the values of beginning/end of the time increments. |
| EPQP | Contains material properties and local grid point coordinates for the linear plastic quad plate element. |
| LEQP | Contains material properties and local grid point coordinates for the linear elastic quad plate element. |
| LOAD | Defines element body force, pressure and traction load (must be preceeded byTIME input option). |
| ISTRES | Defines any initial stress component values (at TIME = 0.0) |
| ISISP | Defines any initial displacement and velocity component values (at TIME = 0.0) |
| PDOF | Displacement and STRESS output print selection (Default = Print All D.O.F.) |

| | |
|---|---|
| PGRD | Local grid number output print control (Default = Print All Grid Points). |
| ICND | Boundary conditions, grid identifications (Default= None Bounded Out) |
| CONT | Execution control parameters - maximum iterations, convergence criteria and output format. |
| END | Require last input for the element. |

## 5.0 INPUT DESCRIPTION

Figure 3 contains an illustrative example of typical user input. A detailed description of each line and field of input, that may be entered for each of the input options summarized in Section 4.0, is contained on the following pages. Input record description contained on these pages includes:

1) Input Code, i.e., "TIME"
2) Record Format, i.e., Field Usage and Mnemonic
3) Record Example, as contained on Figure 3
4) Field Description - verbal explanation of each field in the record along with data type, limits and defaults if any.
5) Qualifying Notes

All input is formatted and is currently read from logical unit 5 "IOIN".

```
----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----8
IME     03              C.0          0.0005        0.0010
ITLE    C2
ELEMENT LEOP TEST OF OUTPUT
        03/ 02/ 84
EQP                                  11538000.  0.3             .0002588
ORD     13C.0           0.0          C.0           1.0
ORD     16C.0           10.0         0.0           1.0
ORD     1410.0          0.0          0.0           1.0
ORD     1510.0          10.0         0.0           1.0
OAD      2 2 1 1 1 1
         0.0             0 0 0 0     0.0             0 0 0 0  -10000.0    0 0 0 1
STRES   C2
        C40.0           C.0          0.C           0.0          0.0         0.0
        C20.C           C.0          0.0           0.0          0.0         0.0
DISP    C3
        C40.0           C.0          C.C           0.0          0.0         0.0
        C20.0           0.0          0.C           C.0          0.0         0.0
        C10.0           0.0          0.0           0.0          0.0         0.0
OF
             1    1    1    1    1    1    1    1    1    1    1    1
RD
             1    1    1    1    1    1    1    1    1    1    1    1    1    1
             1    1    1    1    1    1    1    1    1    1    1    1    1    1
ND      17
             1    2    4    5    6   11   12   13   14   16   17   18   20   21
            22   27   28
NT          3 1         0.01         C.C001
D
```

FIGURE 3.  INPUT SAMPLE

INPUT - TIME (REQUIRED)

FORMAT:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| TIME NT | | T(1) | T(2) | T(3) | T(4) | T(5) | T(6) |
| | T(7) | T(8) | T(NT) | | | | |

EXAMPLE:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| TIME 03 | | 0.00 | 0.0005 | 1.0E-3 | | | |

FIELD DESCRIPTION:

| CARD NO. | FIELD LABEL | FIELD NO. | CONTENTS |
|---|---|---|---|
| 1 | TIME | 1 | THE ALPHANUMERICS "TIME" |
| 1 | NT | 1 | THE NUMBER OF TIME VALUES WHICH FOLLOW (INTEGER 2<NT<25) |
| 1 | T(1)-T(6) | 3 - 8 | THE FIRST 6 TIME VALUES (REAL DATA >0.0) |
| 2 - 4 | T(7)-T(25) | 2 - 8 | THE 7TH THRU THE 25TH TIME VALUES (REAL DATA >0.0) |

INPUT - TITLE

FORMAT:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| TITLE NC | | | | | | | |

80 CHARACTERS OF ALPHANUMERIC DATA

EXAMPLE:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| TITLE 02 | | | | | | | |

TEST OF ELEMENT EPQP
DATE: MARCH 31, 1986

FIELD DESCRIPTION:

| CARD NO. | FIELD LABEL | FIELD NO. | CONTENTS |
|---|---|---|---|
| 1 | TITLE | 1 | THE ALPHANUMERIC "TITLE" |
| 1 | NC | 1 | THE NUMBER OF TITLE CARDS THAT FOLLOW (INTEGER, 1<NC<3) |
| 2 - 4 | | 1 - 8 | ALPHANUMERICS WHICH ARE TO IDENTIFY OUTPUT LISTINGS |

INPUT - EPQP - ELASTIC PLASTIC QUADRILATERAL PLATE ELEMENT

FORMAT:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| EPQP NL | | E | G | AMU | RHO | ALPHA | AJ |
| | YSTR | NU | | | | | |
| CORD IG | XENTER | YENTER | ZENTER | H | | | |

EXAMPLE:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| EPQP 01 | | 2.0 | 1.1538E+7 | 0.3 | .0002588 | 0.2 | |
| | 3000. | 2.0 | | | | | |
| CORD 13 | 0.0 | 0.0 | 0.0 | 1.0 | | | |
| CORD 16 | 0.0 | 10.0 | 0.0 | 1.0 | | | |
| CORD 14 | 10.0 | 0.0 | 0.0 | 1.0 | | | |
| CORD 15 | 10.0 | 10.0 | 0.0 | 1.0 | | | |

FIELD DESCRIPTION:

| CARD NO. | FIELD LABEL | FIELD NO. | CONTENTS |
|---|---|---|---|
| 1 | EPQP | 1 | THE ALPHANUMERIC "EPQP" |
| 1 | NL | 1 | CODE TO PERFORM LINEAR OR NONLINEAR (ITERATIVE) COMPUTATIONS; (INTEGER, 00 = LINEAR, 01 = NONLINEAR) |
| 1 | E | 3 | YOUNG'S MODULUS (REAL > 0.0) |
| 1 | G | 4 | SHEAR MODULUS (REAL > 0.0) |
| 1 | AMU | 5 | POISSON'S RATIO (REAL, 0.0<AMU<0.5) |
| 1 | RHO | 6 | MASS DENSITY (REAL) |
| 1 | ALPHA | 7 | MATERIAL PARAMETER IN PLASTICITY LAW (REAL) |
| 1 | AJ | 8 | MATERIAL PARAMETER IN PLASTICITY LAW (REAL) |
| 2 | YSTR | 2 | NOMINAL YIELD STRESS (REAL) |
| 2 | NU | 3 | ALTERNATE POISSON'S RATIO (NOT USED) (REAL) |
| 3 - 6 | CORD | 1 | THE ALPHANUMERIC "CORD" |
| 3 - 6 | IG | 1 | THE LOCAL GRID NUMBER (INTEGER, 13<IG<16) |
| 3 - 6 | XENTER | 2 | THE LOCAL X-COORDINATE OF GRID POINT IG (REAL) |
| 3 - 6 | YENTER | 3 | THE LOCAL Y-COORDINATE OF GRID POINT IG (REAL) |
| 3 - 6 | ZENTER | 4 | THE LOCAL Z-COORDINATE OF GRID POINT IG (REAL) |
| 3 - 6 | H | 5 | THE THICKNESS OF PLATE AT CORNER CONTAINING LOCAL GRID POINT IG (REAL>0.) |

NOTE: 4 CORD CARDS ARE REQUIRED, ONE EACH FOR LOCAL GRID POINTS 13,14,15 AND 16. IN THE LOCAL COORDINATE SYSTEM GRID POINT 13 MUST BE AT THE ORIGIN AND POINTS 13 - 16 MUST ALL LIE IN THE X-Y PLANE.

INPUT - LEQP - LINEAR ELASTIC QUADRILATERAL PLATE ELEMENT

FORMAT:

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| LEQP | | | | G | AMU | RHO | | |
| CORD | IG | XENTER | YENTER | ZENTER | H | | | |

EXAMPLE:

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| LEQP | | | | 11538000 | 0.3 | 2.588E-4 | | |
| CORD | 13 | 0.0 | 0.0 | 0.0 | 1.0 | | | |
| CORD | 16 | 0.0 | 10.0 | 0.0 | 1.0 | | | |
| CORD | 14 | 10.0 | 0.0 | 0.0 | 1.0 | | | |
| CORD | 15 | 10.0 | 10.0 | 0.0 | 1.0 | | | |



FIELD DESCRIPTION:

| CARD NO. | FIELD LABEL | FIELD NO. | CONTENTS |
|---|---|---|---|
| 1 | LEQP | 1 | THE ALPHANUMERICS "LEQP" |
| 1 | G | 4 | SHEAR MODULUS (REAL > 0.0) |
| 1 | AMU | 5 | POISSON'S RATIO (REAL, 0.0<AMU<0.5) |
| 1 | RHO | 6 | MASS DENSITY (REAL > 0.0) |
| 2 - 5 | CORD | 1 | THE ALPHANUMERIC "CORD" |
| 2 - 5 | IG | 1 | THE LOCAL GRID NUMBER (INTEGER, 13<IG<16) |
| 2 - 5 | XENTER | 2 | THE LOCAL X-COORDINATE OF GRID POINT IG (REAL) |
| 2 - 5 | YENTER | 3 | THE LOCAL Y-COORDINATE OF GRID POINT IG (REAL) |
| 2 - 5 | ZENTER | 4 | THE LOCAL Z-COORDINATE OF GRID POINT IG (REAL) |
| 2 - 5 | H | 5 | THE THICKNESS OF PLATE AT CORNER CONTAINING LOCAL GRID POINT IG (REAL>0.) |

NOTE: 4 CORD CARDS ARE REQUIRED, ONE EACH FOR LOCAL GRID POINTS 13,14,15 AND 16. IN THE LOCAL COORDINATE SYSTEM GRID POINT 13 MUST BE AT THE ORIGIN AND POINTS 13 - 16 MUST ALL LIE IN THE X-Y PLANE.

INPUT - LOAD - ELEMENT LOAD DATA

FORMAT: FOR EQUATION TYPE INPUT It=1 OR It=2

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| LOAD I1 | ItIdIpInIs | | | | | | |
| | COEFFu | XuYuZuTu | COEFFv | XvYvWvTv | COEFFw | XwYwZwTw | |
| | COEFFu | XuYuZuTu | COEFFv | XvYvWvTv | COEFFw | XwYwZwTw | |

FORMAT: FOR TABLE TYPE INPUT It=3

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| LOAD I1 | ItIdIpInIs | | | | | | |
| IG | F(IG,u) | F(IG,v) | F(IG,w) | Fdt(IG,u) | Fdt(IG,v) | Fdt(IG,w) | |

EXAMPLE:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| LOAD 02 | 0201010101 | | | | | | |
| 01 | 0.0 | 00000000 | 0.0 | 00000000 | -10000.0 | 00000001 | |

FIELD DESCRIPTION:

| CARD NO. | FIELD LABEL | FIELD NO. | CONTENTS |
|---|---|---|---|
| 1 | LOAD | 1 | THE ALPHANUMERICS "LOAD" |
| 1 | I1 | 1 | LOAD TYPE CODE (INTEGER; 1, 2 OR 3)<br>1 = BODY FORCE LOAD<br>2 = PRESSURE LOAD<br>3 = TRACTION LOAD |
| 1 | It | 2 | CODE DESCRIBING INPUT IN LINES 2 TO END (INTEGER; 1,2 OR 3)<br>1 OR 2 = EQUATION TYPE INPUT (COEFFICIENTS AND EXPONENTS)<br>3 = FORCES INPUT DIRECTLY AS TABLES |
| 1 | Id | 2 | CODE INDICATING IF ONLY FORCE OR FORCE AND RATE OF FORCE INPUT FOLLOWS (INTEGER, 1 OR 2)<br>1 = FORCE EQUATIONS OR TABLES ONLY<br>2 = FORCE AND RATE OF FORCE EQUATIONS OR TABLES |
| 1 | Ip | 2 | CODE DESCRIBING TIME FUNCTION COMPUTATIONS (INTEGER, 1 OR 2)<br>1 = NON-HERMITIAN COMPUTATIONS<br>2 = HERMITIAN TIME FUNCTIONS (Id MUST BE 2) |
| 1 | In | 2 | (In)*(Id) EQUALS THE NUMBER OF INPUT LINES THAT FOLLOW FOR EQUATION TYPE INPUT AND (In)*(NUMBER OF TIME POINTS) EQUALS THE NUMBER OF INPUT LINES THAT FOLLOW FOR TABLE TYPE INPUT. PERMISSIBLE VALUES OF In ARE GIVEN IN THE TABLE BELOW. |

VALUES OF In IF:

| It | I1 | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| 1,2 | 1 - 28 | 1 - 12 | 1 - 10 |
| 3 | 28,8 | 12,4 | 10,4 |

| CARD NO. | FIELD LABEL | FIELD NO. | CONTENTS |
|---|---|---|---|
| 1 | Is | 2 | CODE DESCRIBING THE SURFACE OR EDGE THAT PRESSURE OR TRACTION LOAD IS APPLIED ON. ENTER 0 FOR BODY FORCE TYPE LOAD. OTHERWISE, REFER TO TABLE BELOW. |

| Is | PRESSURE LOAD SURFACE GRID NUMBERS | TRACTION LOAD EDGE GRID NUMBERS |
|---|---|---|
| 1 | 1 TO 12 (TOP) | 1,2,17,18 EDGE 1 |
| 2 | 17 TO 28 (BOTTOM) | 2,3,28,19 EDGE 2 |
| 3 | N.A. | 3,4,19,20 EDGE 3 |
| 4 | N.A. | 4,1,20,17 EDGE 4 |

FIELD DESCRIPTION:LINE 2 TO (In*Id+1) FOR EQUATION TYPE INPUT

| CARD NO. | FIELD LABEL | FIELD NO. | CONTENTS |
|---|---|---|---|
| 2 -In+1 | COEFFu | 2 | COEFFICIENT OF THIS TERM FOR COMPUTATION OF u DIRECTION FORCE (REAL) |
| 2 -In+1 | Xu,Yu,Zu,Tu | 3 | EXPONENTS OF THE X,Y,Z,T VARIABLES RESPECTIVELY, OF THIS TERM FOR COMPUTATION OF u DIRECTION FORCE (INTEGERS > 0) |
| 2 -In+1 | COEFFv | 4 | COEFFICIENT OF THIS TERM FOR COMPUTATION OF v DIRECTION FORCE (REAL) |
| 2 -In+1 | Xv,Yv,Zv,Tv | 5 | EXPONENTS OF THE X,Y,Z,T VARIABLES RESPECTIVELY, OF THIS TERM FOR COMPUTATION OF v DIRECTION FORCE (INTEGERS > 0) |
| 2 -In+1 | COEFFw | 6 | COEFFICIENT OF THIS TERM FOR COMPUTATION OF w DIRECTION FORCE (REAL) |
| 2 -In+1 | Xw,Yw,Zw,Tw | 7 | EXPONENTS OF THE X,Y,Z,T VARIABLES RESPECTIVELY, OF THIS TERM FOR COMPUTATION OF w DIRECTION FORCE (INTEGERS > 0) |
| In+2 TO (In*Id+1) | | | COEFFICIENTS AND EXPONENTS FOR RATE OF FORCE COMPUTATIONS SIMILAR TO THOSE DESCRIBED ABOVE. |

FIELD DESCRIPTION:LINE 2 TO (In*NTIME+1) FOR TABLE INPUT

| CARD NO. | FIELD LABEL | FIELD NO. | CONTENTS |
|---|---|---|---|
| 2 - In | IG | 1 | GRID NUMBER AT WHICH THIS FORCE IS APPLIED (INTEGER) |
| 2 - In | F(IG,u) | 2 | u-COMPONENT VALUE OF FORCE (REAL) |
| 2 - In | F(IG,v) | 3 | v-COMPONENT VALUE OF FORCE (REAL) |
| 2 - In | F(IG,w) | 4 | w-COMPONENT VALUE OF FORCE (REAL) |
| 2 - In | Fdt(IG,u) | 5 | u-COMPONENT VALUE OF RATE OF FORCE (BLANK IF Id = 1) (REAL) |
| 2 - In | Fdt(IG,v) | 6 | v-COMPONENT VALUE OF RATE OF FORCE (BLANK IF Id = 1) (REAL) |
| 2 - In | Fdt(IG,w) | 7 | w-COMPONENT VALUE OF RATE OF FORCE (BLANK IF Id = 1) (REAL) |

NOTE: THE ABOVE INPUT IS REPEATED FOR EACH TIME POINT IN THE TIME INPUT LINE.

INPUT - ISTRES - INITIAL STRESS CONDITIONS

FORMAT:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| ISTRES NS | | | | | | | |
| IG | SXX | SYY | SZZ | SXY | SXZ | SYZ | |

EXAMPLE:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| ISTRES 02 | | | | | | | |
| 04 | 1000.0 | 2000. | 150. | 300.0 | 1.0E+4 | 312.0 | |
| 02 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | |

FIELD DESCRIPTION:

| CARD NO. | FIELD LABEL | FIELD NO. | CONTENTS |
|---|---|---|---|
| 1 | ISTRES | 1 | THE ALPHANUMERICS "ISTRES" |
| 1 | NS | 1 | THE NUMBER OF INITIAL STRESS CONDITIONS THAT FOLLOW (INTEGER, 1<NS<28) |
| 2-NS+1 | IG | 1 | LOCAL GRID POINT NUMBER FOR THIS STRESS (INTEGER; 1<IG<28) |
| 2-NS+1 | SXX | 2 | SXX STRESS COMPONENT (REAL) |
| 2-NS+1 | SYY | 3 | SYY STRESS COMPONENT (REAL) |
| 2-NS+1 | SZZ | 4 | SZZ STRESS COMPONENT (REAL) |
| 2-NS+1 | SXY | 5 | SXY STRESS COMPONENT (REAL) |
| 2-NS+1 | SXZ | 6 | SXZ STRESS COMPONENT (REAL) |
| 2-NS+1 | SYZ | 7 | SYZ STRESS COMPONENT (REAL) |

INPUT - IDISP - INITIAL VALUES OF DISPLACEMENT

FORMAT:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| IDISP ND | | | | | | | |
| IG | D(IG,u) | D(IG,v) | D(IG,w) | Ddt(IG,u) | Ddt(IG,v) | Ddt(IG,w) | |

EXAMPLE:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| IDISP 02 | | | | | | | |
| 03 | 0.0 | 0.0 | -0.00005 | 0.0 | 0.0 | 0.0 | |
| 19 | 0.0 | 0.0 | -0.00005 | 0.0 | 0.0 | 0.0 | |

FIELD DESCRIPTION:

| CARD NO. | FIELD LABEL | FIELD NO. | CONTENTS |
|---|---|---|---|
| 1 | IDISP | 1 | THE ALPHANUMERICS "IDISP" |
| 1 | ND | 1 | THE NUMBER OF INITIAL DISPLACEMENT VALUES BEING INPUT |
| 2-ND+1 | IG | 1 | LOCAL GRID POINT NUMBER FOR THIS DISPLACEMENT (INTEGER BETWEEN 1 AND 28) |
| 2-ND+1 | D(IG,u) | 2 | u-COMPONENT VALUE OF DISPLACEMENT (REAL) |
| 2-ND+1 | D(IG,v) | 3 | v-COMPONENT VALUE OF DISPLACEMENT (REAL) |
| 2-ND+1 | D(IG,w) | 4 | w-COMPONENT VALUE OF DISPLACEMENT (REAL) |
| 2-ND+1 | Ddt(IG,u) | 5 | u-COMPONENT VALUE OF DISPLACEMENT RATE (REAL) |
| 2-ND+1 | Ddt(IG,v) | 6 | v-COMPONENT VALUE OF DISPLACEMENT RATE (REAL) |
| 2-ND+1 | Ddt(IG,w) | 7 | w-COMPONENT VALUE OF DISPLACEMENT RATE (REAL) |

INPUT - PDOF -DISPLACEMENT AND STRESS PRINT OPTIONS (DEFAULT = PRINT ALL)

FORMAT:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| PDOF | | | | | | | |
| | DSPU DSPV | DSPW VELU | VELV VELW | PSXX PSYY | PSZZ PSXY | PSXZ PSYZ | |

EXAMPLE:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| PDOF | | | | | | | |
| | 1 0 | 1 1 | 0 1 | 1 1 | 1 0 | 0 0 | |

FIELD DESCRIPTION:

| CARD NO. | FIELD LABEL | FIELD NO. | CONTENTS |
|---|---|---|---|
| 1 | PDOF | 1 | THE ALPHANUMERICS "PDOF" |
| 2 | DSPU | 2A | DISPLACEMENT IN U DIRECTION (1 = PRINT; 0 = NO PRINT) |
| 2 | DSPV | 2B | DISPLACEMENT IN V DIRECTION (1 = PRINT; 0 = NO PRINT) |
| 2 | DSPW | 3A | DISPLACEMENT IN W DIRECTION (1 = PRINT; 0 = NO PRINT) |
| 2 | VELU | 3B | VELOCITY IN U DIRECTION (1 = PRINT; 0 = NO PRINT) |
| 2 | VELV | 4A | VELOCITY IN V DIRECTION (1 = PRINT; 0 = NO PRINT) |
| 2 | VELW | 4B | VELOCITY IN W DIRECTION (1 = PRINT; 0 = NO PRINT) |
| 2 | PSXX | 5A | STRESS COMPONENT SXX (1 = PRINT; 0 = NO PRINT) |
| 2 | PSYY | 5B | STRESS COMPONENT SYY (1 = PRINT; 0 = NO PRINT) |
| 2 | PSZZ | 6A | STRESS COMPONENT SZZ (1 = PRINT; 0 = NO PRINT) |
| 2 | PSXY | 6B | STRESS COMPONENT SXY (1 = PRINT; 0 = NO PRINT) |
| 2 | PSXZ | 7A | STRESS COMPONENT SXZ (1 = PRINT; 0 = NO PRINT) |
| 2 | PSYZ | 7B | STRESS COMPONENT SYZ (1 = PRINT; 0 = NO PRINT) |

INPUT - PGRD - LOCAL GRID NUMBER PRINT CONTROL (DEFAULT = PRINT ALL)

FORMAT:

| PGRD | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | P1 | P2 | P3 | P4 | P5 | P6 | P7 | P8 | P9 | P10 | P11 | P12 | P13 | P14 |
| | P15 | P16 | P17 | P18 | P19 | P20 | P21 | P22 | P23 | P24 | P25 | P26 | P27 | P28 |

EXAMPLE:

| PGRD | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 |
| | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |



FIELD DESCRIPTION:

| CARD NO. | FIELD LABEL | FIELD NO. | CONTENTS |
|---|---|---|---|
| 1 | PGRD | 1 | THE ALPHANUMERICS "PGRD" |
| 2 | P(1)-P(14) | 2A - 8B | PRINT CONTROL FOR LOCAL GRID POINT NUMBERS 1 - 14 (1 = PRINT; 0 = NO PRINT) |
| 3 | P(15)-P(28) | 2A - 8B | PRINT CONTROL FOR LOCAL GRID POINT NUMBERS 15 - 28 (1 = PRINT; 0 = NO PRINT) |

NOTE: INTEGER INPUT REQUIRED. RIGHT JUSTIFY.

INPUT - ICND - BOUNDED GRID POINT IDENTIFICATION (DEFAULT = NONE BOUNDED OUT)

FORMAT:

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| ICND NB | | | | | | | | |
| | N(1) N(2) | N(3) - | - - | - - | - - | - - | - N(14) | |
| | N(15) - | - - | N(NB) | | | | | |

EXAMPLE:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| ICND 17 | | | | | | | |
| | 1 11 | 12 2 | 16 13 | 20 27 | 28 17 | 5 6 | 3 14 |
| | 21 22 | 18 | | | | | |



FIELD DESCRIPTION:

| CARD NO. | FIELD LABEL | FIELD NO. | CONTENTS |
|---|---|---|---|
| 1 | ICND | 1 | THE ALPHANUMERICS "ICND" |
| 1 | NB | 1 | THE NUMBER OF BOUNDED GRID POINTS (LOCAL) IDENTIFIED ON LINES 2 OR 2 AND 3 (INTEGER - RIGHT JUSTIFIED; 1<NB<27) |
| 2 | N(1)-N(14) | 2A - 8B | LOCAL GRID POINTS BOUNDED OUT OF PROBLEM (INTEGERS BETWEEN 1 AND 28) |
| 3 | N(15)-N(NB) | 2A - 8B | LOCAL GRID POINTS BOUNDED OUT OF PROBLEM (INTEGERS BETWEEN 1 AND 28) |

INPUT - CONT - PROBLEM EXECUTION CONTROL PARAMETERS (REQUIRED)

FORMAT:

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| CONT | MiPc | CRITR | DELTM | | | | | |

EXAMPLE:

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| CONT | 1002 | .05 | 1.0E-04 | | | | | |

FIELD DESCRIPTION:

| CARD NO. | FIELD LABEL | FIELD NO. | CONTENTS |
|---|---|---|---|
| 1 | CONT | 1 | THE ALPHANUMERICS "CONT" |
| 1 | Mi | 2 | THE MAXIMUM NUMBER OF ITERATIONS TO EXECUTE; DEFAULT TO 3 IF RANGE EXCEEDED. (INTEGER BETWEEN 1 AND 20) |
| 1 | Pc | 2 | PRINTED OUTPUT FORMAT (INTEGER; 1 OR 2) DEFAULT = 1<br>1 = PRINT GRID POINT VALUES AT ALL TIMES<br>2 = PRINT ALL GRID POINT VALUES FOR THIS TIME |
| 1 | CRITR | 3 | THE CONVERGENCE CRITERIA FOR ALL DISPLACEMENT VALUES; RELATIVE CONVERGENCE, DEFAULT TO 0.01 (REAL > 0.) |
| 1 | DELTM | 4 | PRINTED OUTPUT TIME INCREMENT |

INPUT - END (REQUIRED LAST INPUT)

FORMAT AND EXAMPLE:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| END | | | | | | | |

## 6.0 OUTPUT OVERVIEW

Typical output is illustrated in Section 7, Figure 5. An echo print of the user input is always printed first. The echo print is followed by a group of program controlled output which contains:

1. Computed local coordinates of analysis element
2. Labeled material properties, as input
3. Tables giving element load values in the local coordinate system for each input time slice
4. Table of input initial stress and displacement values.

The third data output grouping is output each iteration and contains the displacement/stress data computed that iteration. This output is only at the input time slices. This data is not present for the LEQP case since only one iteration is performed.

The final output consits of displacement/stress data at the requested print time increments upon convergence of the problem. The printed format is operator controlled for this grouping.

## 7.0 OUTPUT EXAMPLE

A quadrilateral plate of constant thickness is sued to illustrate the input-output format of SFENES. Table 1 provides the required input to solve a linear quad plate problem and Figure 4 shows the geometric layout of the problem plate. Used input data is illustrated in Figure 3 and each input record is described in Section 5 of this report.

Problem output is illustrated in Figure 5. A description of this output is contained in Section 6 of this report.. The output contrived here is only partial (unbounded D.O.F. only) in order to conserve space.

## TABLE 1.

## QUADRILATERAL PLATE MATERIAL PROPERTIES, COORDINATE INPUT, LOAD EQUIPMENT AND INITIAL VALUES

(1) Material Properties

$G = 1.1538 \times 10^7$

$\rho = .2588 \times 10^{-3}$

$\mu = .30$

(2) Spatal Coordinates

| Grid No. | X | Y | Z | Thickness |
|---|---|---|---|---|
| 13 | 0 | 0 | 0 | 1.0 |
| 14 | 10.0 | 10.0 | 0 | 1.0 |
| 15 | 10.0 | 10.0 | 0 | 1.0 |
| 16 | 0.0 | 10.0 | 0 | 1.0 |

(3) Time Coordinates

0.0

0.0005

0.0010

(4) Element Load

Pressure Load on Top Surface of

-10,000t or -10,000t in W dir

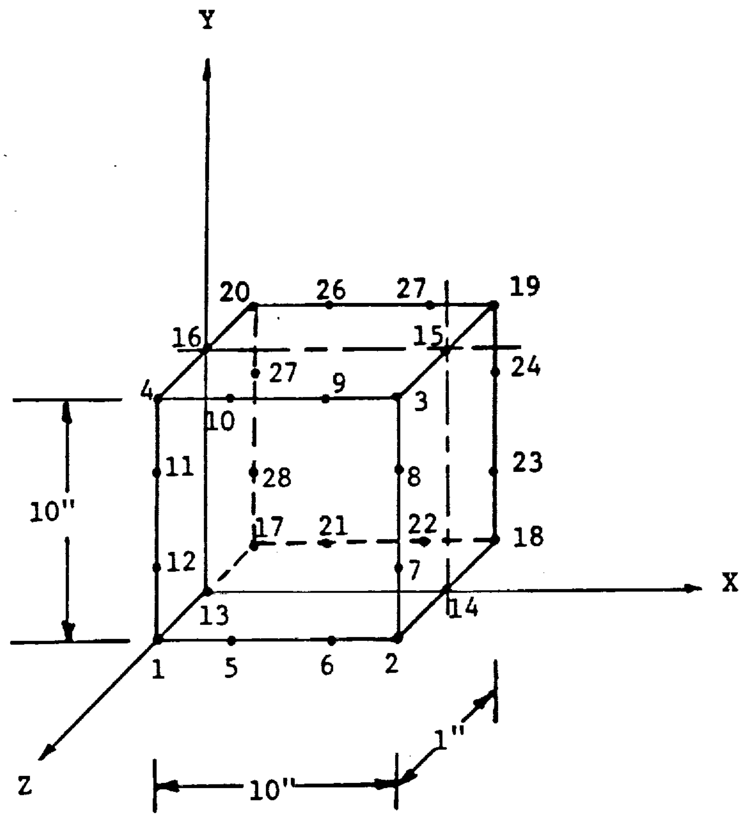
(5) Initial Values

Stress = 0.0 at all grids

Displacement = 0.0 at all grids

FIGURE 4

QUAD PLATE DIMENSIONS




| | |
|---|---|
| LOAD AT GRID POINTS | 1-12 |
| DIRECTION | +Z |
| VALUE | -10,000t |

***** I N P U T   E C H O *****

FIGURE 5.

```
TIME      3              0.0              0.5000001E-03  0.9999999E-03
TITLE     2
 ELEMENT LEQP TEST OF OUTPUT
         03/ 02/ 84
LEQP                                      0.1153800E+08  0.3000000E+00  0.2588001E-03
CORD     13  0.0            0.0           0.0            0.1000000E+01
CORD     16  0.0            0.1000000E+02 0.0            0.1000000E+01
CORD     14  0.1000000E+02  0.0           0.0            0.1000000E+01
CORD     15  0.1000000E+02  0.1000000E+02 0.0            0.1000000E+01
LOAD      2 2 1 1 1 1
             0.0            0  0  0  0    0.0            0  0  0  0   -0.1000000E+05  0  0  0  1
ISTRES    2
          4  0.0            0.0           0.0            0.0           0.0           0.0
          2  0.0            0.0           0.0            0.0           0.0           0.0
IDISP     3
          4  0.0            0.0           0.0            0.0           0.0           0.0
          2  0.0            0.0           0.0            0.0           0.0           0.0
          1  0.0            0.0           0.0            0.0           0.0           0.0
PDOF
                1     1     1     1     1     1     1     1     1     1     1     1
PGEO
                1     1     1     1     1     1     1     1     1     1     1     1     1     1
                1     1     1     1     1     1     1     1     1     1     1     1     1     1
ICND     17
                1     2     4     5     6    11    12    13    14    16    17    18    20    21
               22    27    28
CONT        2 1             0.1000000E-01 0.1000000E-03
```

```
X-COORD
  0.0            0.1000000E+02  0.1000000E+02  0.0            0.3333333E+01  0.6666666E+01  0.1000000E+02  0.1000000E+02
  0.6666667E+01  0.3333334E+01  0.0            0.0            0.0            0.1000000E+02  0.1000000E+02  0.0
  0.0            0.1000000E+02  0.1000000E+02  0.0            0.3333333E+01  0.6666666E+01  0.1000000E+02  0.1000000E+02
  0.6666667E+01  0.3333334E+01  0.0            0.0
Y-COORD
  0.0            0.0            0.1000000E+02  0.1000000E+02  0.0            0.0            0.3333333E+01  0.6666666E+01
  0.1000000E+02  0.1000000E+02  0.6666667E+01  0.3333334E+01  0.0            0.0            0.1000000E+02  0.1000000E+02
  0.0            0.0            0.1000000E+02  0.1000000E+02  0.0            0.0            0.3333333E+01  0.6666666E+01
  0.1000000E+02  0.1000000E+02  0.6666667E+01  0.3333334E+01
Z-COORD
  0.5000000E+00  0.5000000E+00  0.5000000E+00  0.5000000E+00  0.5000000E+00  0.5000000E+00  0.5000000E+00  0.5000000E+00
  0.5000000E+00  0.5000000E+00  0.5000000E+00  0.5000000E+00  0.0            0.0            0.0            0.0
 -0.5000000E+00 -0.5000000E+00 -0.5000000E+00 -0.5000000E+00 -0.5000000E+00 -0.5000000E+00 -0.5000000E+00 -0.5000000E+00
 -0.5000000E+00 -0.5000000E+00 -0.5000000E+00 -0.5000000E+00
CORNER THICKNESS
  0.1000000E+01  0.1000000E+01  0.1000000E+01  0.1000000E+01
G
  0.1153900E+09
RHO
  0.2588001E-03
AMU
  0.3000000E+00
ALPHA
  0.0
NU
         0
E
  0.0
YSTR
  0.0
AJ
  0.0
LOAD CODE
         0         2         0         0         0         0         0
NONLIN
         0
```

```
 LCODE        7 X    6
ROW  COL =    1   COL =    2   COL =    3   COL =    4   COL =    5   COL =    6   COL =
  1           0            0            0            0            0            0
  2           0            0            0            0           12            0
  3           0            0            0            0            0            0
  4           0            0            0            0            0            0
  5           0            0            0            0            0            0
  6           0            0            0            0            0            0
  7           0            0            0            0            0            0
 TIME =   0.0            LOAD
   0.0            0.0            0.0
   0.0            0.0            0.0
   0.0            0.0            0.0
   0.0            0.0            0.0
   0.0            0.0            0.0
   0.0            0.0            0.0
   0.0            0.0            0.0
   0.0            0.0            0.0
   0.0            0.0            0.0
   0.0            0.0            0.0
   0.0            0.0            0.0
   0.0            0.0            0.0
 TIME =   0.5000001E-03 LOAD
   0.0            0.0           -0.5000000E+01
   0.0            0.0           -0.5000000E+01
   0.0            0.0           -0.5000000E+01
   0.0            0.0           -0.5000000E+01
   0.0            0.0           -0.5000000E+01
   0.0            0.0           -0.5000000E+01
   0.0            0.0           -0.5000000E+01
   0.0            0.0           -0.5000000E+01
   0.0            0.0           -0.5000000E+01
   0.0            0.0           -0.5000000E+01
   0.0            0.0           -0.5000000E+01
   0.0            0.0           -0.5000000E+01
 TIME =   0.9999999E-03 LOAD
   0.0            0.0           -0.9999999E+01
   0.0            0.0           -0.9999999E+01
   0.0            0.0           -0.9999999E+01
   0.0            0.0           -0.9999999E+01
   0.0            0.0           -0.9999999E+01
   0.0            0.0           -0.9999999E+01
   0.0            0.0           -0.9999999E+01
   0.0            0.0           -0.9999999E+01
   0.0            0.0           -0.9999999E+01
   0.0            0.0           -0.9999999E+01
   0.0            0.0           -0.9999999E+01
   0.0            0.0           -0.9999999E+01
 INITIAL STRESS
   0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
   0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
   0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
   0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
   0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
   0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
   0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
   0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
   0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
   0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
   0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
   0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
   0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
```

```
    0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
    0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
    0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
    0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
    0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
    0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
    0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
    0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
 INITIAL DISPLACEMENT
    0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
    0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
    0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
    0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
    0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
    0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
    0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
    0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
    0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
    0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
    0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
    0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
    0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
    0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
    0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
    0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
    0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
    0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
    0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
    0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
    0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
 **** ERROR RETURN FROM GELG =   0 ****
```

GRID NO. 1

| TIME | DISPLACEMENT U | DISPLACEMENT V | DISPLACEMENT W | VELOCITY U | VELOCITY V | VELOCITY W |
|---|---|---|---|---|---|---|
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.1000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.2000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.3000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.3999998E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5000001E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5999999E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.7000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.8000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.8999999E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.9999999E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

GRID NO. 2

| TIME | DISPLACEMENT U | DISPLACEMENT V | DISPLACEMENT W | VELOCITY U | VELOCITY V | VELOCITY W |
|---|---|---|---|---|---|---|
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.1000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.2000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.3000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.3999998E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5000001E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5999999E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.7000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.8000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.8999999E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.9999999E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

GRID NO. 3

| TIME | DISPLACEMENT U | DISPLACEMENT V | DISPLACEMENT W | VELOCITY U | VELOCITY V | VELOCITY W |
|---|---|---|---|---|---|---|
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.1000000E-03 | 0.1669403E-05 | 0.1663997E-05 | -0.4054439E-04 | 0.3237654E-01 | 0.3228829E-01 | -0.7786791E+00 |
| 0.2000000E-03 | 0.6272990E-05 | 0.6259314E-05 | -0.1492940E-03 | 0.5868348E-01 | 0.5862614E-01 | -0.1364100E+01 |
| 0.3000000E-03 | 0.1320378E-04 | 0.1319089E-04 | -0.3069225E-03 | 0.7892102E-01 | 0.7901382E-01 | -0.1756266E+01 |
| 0.3999998E-03 | 0.2185482E-04 | 0.2186370E-04 | -0.4941043E-03 | 0.9308881E-01 | 0.9345108E-01 | -0.1955171E+01 |
| 0.5000001E-03 | 0.3161927E-04 | 0.3168281E-04 | -0.6915156E-03 | 0.1011873E+00 | 0.1019382E+00 | -0.1960822E+01 |
| 0.5999999E-03 | 0.3840125E-04 | 0.3844585E-04 | -0.8352145E-03 | 0.4007772E-01 | 0.3916741E-01 | -0.9940331E+00 |
| 0.7000000E-03 | 0.4075980E-04 | 0.4068510E-04 | -0.9064956E-03 | 0.1271820E-01 | 0.1146138E-01 | -0.5124630E+00 |
| 0.8000003E-03 | 0.4206989E-04 | 0.4190695E-04 | -0.9538808E-03 | 0.1910886E-01 | 0.1881978E-01 | -0.5161122E+00 |
| 0.8999999E-03 | 0.4570659E-04 | 0.4561788E-04 | -0.1025892E-02 | 0.5924904E-01 | 0.6124227E-01 | -0.1004972E+01 |
| 0.9999999E-03 | 0.5504477E-04 | 0.5532429E-04 | -0.1171051E-02 | 0.1331398E+00 | 0.1387298E+00 | -0.1979060E+01 |

GRID NO. 4

| TIME | DISPLACEMENT U | DISPLACEMENT V | DISPLACEMENT W | VELOCITY U | VELOCITY V | VELOCITY W |
|---|---|---|---|---|---|---|
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.1000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.2000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.3000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.3999998E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5000001E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5999999E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.7000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.8000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.8999999E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.9999999E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

GRID NO. 5

| TIME | DISPLACEMENT U | DISPLACEMENT V | DISPLACEMENT W | VELOCITY U | VELOCITY V | VELOCITY W |
|---|---|---|---|---|---|---|
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.1000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.2000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.3000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.3999998E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5000001E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5999999E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.7000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.8000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.8999999E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.9999999E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

GRID NO. 6

| TIME | DISPLACEMENT U | DISPLACEMENT V | DISPLACEMENT W | VELOCITY U | VELOCITY V | VELOCITY W |
|---|---|---|---|---|---|---|
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.1000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.2000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.3000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.3999998E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5000001E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5999999E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.7000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.8000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.8999999E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.9999999E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

GRID NO. 7

| TIME | DISPLACEMENT U | DISPLACEMENT V | DISPLACEMENT W | VELOCITY U | VELOCITY V | VELOCITY W |
|---|---|---|---|---|---|---|
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.1000000E-03 | 0.3225329E-06 | 0.2183320E-05 | -0.9942053E-05 | 0.6214779E-02 | 0.4172725E-01 | -0.1898656E+00 |
| 0.2000000E-03 | 0.1195777E-05 | 0.7957626E-05 | -0.3617797E-04 | 0.1101420E-01 | 0.7181942E-01 | -0.3258761E+00 |
| 0.3000000E-03 | 0.2478196E-05 | 0.1615938E-04 | -0.7332212E-04 | 0.1439830E-01 | 0.9027678E-01 | -0.4080325E+00 |
| 0.3999998E-03 | 0.4028253E-05 | 0.2562509E-04 | -0.1159891E-03 | 0.1636703E-01 | 0.9709895E-01 | -0.4363334E+00 |
| 0.5000001E-03 | 0.5704430E-05 | 0.3519139E-04 | -0.1587938E-03 | 0.1692045E-01 | 0.9228629E-01 | -0.4107802E+00 |
| 0.5999999E-03 | 0.6936333E-05 | 0.4241010E-04 | -0.1914533E-03 | 0.8395758E-02 | 0.5480688E-01 | -0.2530695E+00 |
| 0.7000000E-03 | 0.7519197E-05 | 0.4669650E-04 | -0.2115394E-03 | 0.3939573E-02 | 0.3363953E-01 | -0.1593109E+00 |
| 0.8000000E-03 | 0.7859864E-05 | 0.4968174E-04 | -0.2254470E-03 | 0.3551381E-02 | 0.2878423E-01 | -0.1295038E+00 |
| 0.8999999E-03 | 0.8365192E-05 | 0.5299707E-04 | -0.2395718E-03 | 0.7232644E-02 | 0.4024063E-01 | -0.1636479E+00 |
| 0.9999999E-03 | 0.9442016E-05 | 0.5827364E-04 | -0.2603086E-03 | 0.1498196E-01 | 0.6800932E-01 | -0.2617448E+00 |

GRID NO. 8

| TIME | DISPLACEMENT U | DISPLACEMENT V | DISPLACEMENT W | VELOCITY U | VELOCITY V | VELOCITY W |
|---|---|---|---|---|---|---|
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.1000000E-03 | 0.1133070E-05 | 0.2430141E-05 | -0.2655422E-04 | 0.2186724E-01 | 0.4671912E-01 | -0.5085227E+00 |
| 0.2000000E-03 | 0.4214608E-05 | 0.8967078E-05 | -0.9719204E-04 | 0.3896923E-01 | 0.8213562E-01 | -0.8816684E+00 |
| 0.3000000E-03 | 0.8768077E-05 | 0.1848052E-04 | -0.1983755E-03 | 0.5130607E-01 | 0.1062498E+00 | -0.1119441E+01 |
| 0.3999998E-03 | 0.1431695E-04 | 0.2984023E-04 | -0.3165670E-03 | 0.5887758E-01 | 0.1190613E+00 | -0.1221836E+01 |
| 0.5000001E-03 | 0.2038477E-04 | 0.4191609E-04 | -0.4332308E-03 | 0.6168398E-01 | 0.1205705E+00 | -0.1188858E+01 |
| 0.5999999E-03 | 0.2472027E-04 | 0.5062987E-04 | -0.5286639E-03 | 0.2796507E-01 | 0.5899037E-01 | -0.6609318E+00 |
| 0.7000000E-03 | 0.2655545E-04 | 0.5477107E-04 | -0.5786400E-03 | 0.1187702E-01 | 0.2911801E-01 | -0.3797050E+00 |
| 0.8000000E-03 | 0.2768337E-04 | 0.5751041E-04 | -0.6128282E-03 | 0.1341994E-01 | 0.3095343E-01 | -0.3451751E+00 |
| 0.8999999E-03 | 0.2983715E-04 | 0.6201869E-04 | -0.6558986E-03 | 0.3259344E-01 | 0.6449628E-01 | -0.5573416E+00 |
| 0.9999999E-03 | 0.3478982E-04 | 0.7146665E-04 | -0.7325206E-03 | 0.6939816E-01 | 0.1297473E+00 | -0.1016210E+01 |

GRID NO. 9

| TIME | DISPLACEMENT U | DISPLACEMENT V | DISPLACEMENT W | VELOCITY U | VELOCITY V | VELOCITY W |
|---|---|---|---|---|---|---|
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.1000000E-03 | 0.2428573E-05 | 0.1122606E-05 | -0.2650106E-04 | 0.4668644E-01 | 0.2168108E-01 | -0.5075688E+00 |
| 0.2000000E-03 | 0.8960270E-05 | 0.4182002E-05 | -0.9702312E-04 | 0.8206218E-01 | 0.3873572E-01 | -0.8804166E+00 |
| 0.3000000E-03 | 0.1846399E-04 | 0.8715539E-05 | -0.1980939E-03 | 0.1061276E+00 | 0.5116405E-01 | -0.1118547E+01 |
| 0.3999998E-03 | 0.2980871E-04 | 0.1426057E-04 | -0.3162413E-03 | 0.1188822E+00 | 0.5896587E-01 | -0.1221958E+01 |
| 0.5000001E-03 | 0.4186349E-04 | 0.2035452E-04 | -0.4379954E-03 | 0.1203266E+00 | 0.6214141E-01 | -0.1190651E+01 |
| 0.5999999E-03 | 0.5057111E-04 | 0.2465663E-04 | -0.5282774E-03 | 0.5907350E-01 | 0.2702857E-01 | -0.6568985E+00 |
| 0.7000000E-03 | 0.5472753E-04 | 0.2638566E-04 | -0.5777548E-03 | 0.2930084E-01 | 0.1067934E-01 | -0.3745543E+00 |
| 0.8000000E-03 | 0.5748066E-04 | 0.2741795E-04 | -0.6115683E-03 | 0.3100881E-01 | 0.1309350E-01 | -0.3436152E+00 |
| 0.8999999E-03 | 0.6197862E-04 | 0.2962982E-04 | -0.6548583E-03 | 0.6419683E-01 | 0.3427092E-01 | -0.5640801E+00 |
| 0.9999999E-03 | 0.7136942E-C4 | 0.3489763E-04 | -0.7327653E-03 | 0.1288657E+00 | 0.7421213E-01 | -0.1035956E+01 |

GRID NO. 10

| TIME | DISPLACEMENT U | DISPLACEMENT V | DISPLACEMENT W | VELOCITY U | VELOCITY V | VELOCITY W |
|---|---|---|---|---|---|---|
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.1000000E-03 | 0.2176504E-05 | 0.3174883E-06 | -0.9904875E-05 | 0.4160166E-01 | 0.6126571E-02 | -0.1891975E+00 |
| 0.2000000E-03 | 0.7934637E-05 | 0.1180671E-05 | -0.3605940E-04 | 0.7163239E-01 | 0.1091387E-01 | -0.3249915E+00 |
| 0.3000000E-03 | 0.1611729E-04 | 0.2455622E-05 | -0.7312310E-04 | 0.9009242E-01 | 0.1436194E-01 | -0.4073828E+00 |
| 0.3999998E-03 | 0.2556738E-04 | 0.4008411E-05 | -0.1157557E-03 | 0.9698153E-01 | 0.1647073E-01 | -0.4363703E+00 |
| 0.5000001E-03 | 0.3512795E-04 | 0.5705131E-05 | -0.1586172E-03 | 0.9229994E-01 | 0.1724029E-01 | -0.4119552E+00 |
| 0.5999999E-03 | 0.4232749E-04 | 0.6922858E-05 | -0.1911791E-03 | 0.5446156E-01 | 0.7900871E-02 | -0.2504451E+00 |
| 0.7000000E-03 | 0.4657425E-04 | 0.7442618E-05 | -0.2109384E-03 | 0.3324343E-01 | 0.3280889E-02 | -0.1559018E+00 |
| 0.8000000E-03 | 0.4953018E-04 | 0.7736349E-05 | -0.2245916E-03 | 0.2864545E-01 | 0.3380333E-02 | -0.1283255E+00 |
| 0.8999999E-03 | 0.5285733E-04 | 0.8276001E-05 | -0.2388357E-03 | 0.4066742E-01 | 0.8199159E-02 | -0.1677151E+00 |
| 0.9999999E-03 | 0.5821772E-04 | 0.9533503E-05 | -0.2603671E-03 | 0.6930989E-01 | 0.1773748E-01 | -0.2740725E+00 |

GRID NO. 11

| TIME | DISPLACEMENT U | DISPLACEMENT V | DISPLACEMENT W | VELOCITY U | VELOCITY V | VELOCITY W |
|---|---|---|---|---|---|---|
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.1000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.2000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.3000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.3999998E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5000001E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5999999E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.7000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.8000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.8999999E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.9999999E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

GRID NO. 12

| TIME | DISPLACEMENT U | DISPLACEMENT V | DISPLACEMENT W | VELOCITY U | VELOCITY V | VELOCITY W |
|---|---|---|---|---|---|---|
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.1000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.2000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.3000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.3999998E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5000001E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5999999E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.7000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.8000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.8999999E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.9999999E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

GRID NO. 13

| TIME | DISPLACEMENT U | DISPLACEMENT V | DISPLACEMENT W | VELOCITY U | VELOCITY V | VELOCITY W |
|---|---|---|---|---|---|---|
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.1000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.2000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.3000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.3999998E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5000001E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5999999E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.7000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.8000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.8999999E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.9999999E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

GRID NO. 14

| TIME | DISPLACEMENT U | DISPLACEMENT V | DISPLACEMENT W | VELOCITY U | VELOCITY V | VELOCITY W |
|---|---|---|---|---|---|---|
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.1000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.2000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.3000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.3999958E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5000001E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5999999E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.7000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.8000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.8999999E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.9999999E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

GRID NO. 15

| TIME | DISPLACEMENT U | DISPLACEMENT V | DISPLACEMENT W | VELOCITY U | VELOCITY V | VELOCITY W |
|---|---|---|---|---|---|---|
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.1000000E-03 | 0.2283483E-07 | 0.2763175E-07 | -0.4055368E-04 | 0.4137426E-03 | 0.5049887E-03 | -0.7788492E+00 |
| 0.2000000E-03 | 0.7415764E-07 | 0.9146839E-07 | -0.1493247E-03 | 0.5697580E-03 | 0.7240979E-03 | -0.1364342E+01 |
| 0.3000000E-03 | 0.1281956E-06 | 0.1629220E-06 | -0.3069770E-03 | 0.4680469E-03 | 0.6573279E-03 | -0.1756483E+01 |
| 0.3999998E-03 | 0.1591761E-06 | 0.2134046E-06 | -0.4941751E-03 | 0.1086104E-03 | 0.3046801E-03 | -0.1955266E+01 |
| 0.5000001E-03 | 0.1413266E-06 | 0.2143286E-06 | -0.6915859E-03 | -0.5085564E-03 | -0.3338503E-03 | -0.1960698E+01 |
| 0.5999999E-03 | 0.1704271E-06 | 0.2551291E-06 | -0.8352874E-03 | 0.8979102E-03 | 0.9666448E-03 | -0.9941858E+00 |
| 0.7000000E-03 | 0.2823759E-06 | 0.3710135E-06 | -0.9065922E-03 | 0.1148404E-02 | 0.1167828E-02 | -0.5127570E+00 |
| 0.8000000E-03 | 0.3615755E-06 | 0.4520510E-06 | -0.9540080E-03 | 0.2429232E-03 | 0.2697003E-03 | -0.5164045E+00 |
| 0.8999999E-03 | 0.2924284E-06 | 0.3883101E-06 | -0.1026043E-02 | -0.1818521E-02 | -0.1727730E-02 | -0.1005129E+01 |
| 0.9999959E-03 | -0.4066241E-07 | 0.6986005E-07 | -0.1171204E-02 | -0.5035952E-02 | -0.4824486E-02 | -0.1978937E+01 |

GRID NO. 16

| TIME | DISPLACEMENT U | DISPLACEMENT V | DISPLACEMENT W | VELOCITY U | VELOCITY V | VELOCITY W |
|---|---|---|---|---|---|---|
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.1000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.2000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.3000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.3999998E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5000001E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5999999E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.7000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.8000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.8999999E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.9999999E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

GRID NO. 17

| | DISPLACEMENT | | | VELOCITY | | |
|---|---|---|---|---|---|---|
| TIME | U | V | W | U | V | W |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.1000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.2000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.3000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.3999998E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5000001E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5999999E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.7000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.8000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.8999999E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.9999999E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

GRID NO. 18

| TIME | DISPLACEMENT U | DISPLACEMENT V | DISPLACEMENT W | VELOCITY U | VELOCITY V | VELOCITY W |
|---|---|---|---|---|---|---|
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.1000000E-03 | 0.0 | C.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.2000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.3000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.3999998E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5000001E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5999999E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.7000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.8000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.8999999E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.9999959E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

GRID NO. 19

| TIME | DISPLACEMENT U | DISPLACEMENT V | DISPLACEMENT W | VELOCITY U | VELOCITY V | VELOCITY W |
|---|---|---|---|---|---|---|
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.1000000E-03 | -0.1623422E-05 | -0.1608434E-05 | -0.4053158E-04 | -0.3154340E-01 | -0.3127287E-01 | -0.7784462E+00 |
| 0.2000000E-03 | -0.6123661E-05 | -0.6075398E-05 | -0.1492522E-03 | -0.5753615E-01 | -0.5717037E-01 | -0.1363775E+01 |
| 0.3000000E-03 | -0.1294563E-04 | -0.1286334E-04 | -0.3068496E-03 | -0.7797843E-01 | -0.7769275E-01 | -0.1755990E+01 |
| 0.3999998E-03 | -0.2153429E-04 | -0.2143474E-04 | -0.4940121E-03 | -0.9287000E-01 | -0.9283972E-01 | -0.1955086E+01 |
| 0.5000001E-03 | -0.3133467E-04 | -0.3125216E-04 | -0.6914304E-03 | -0.1022112E+00 | -0.1026117E+00 | -0.1961068E+01 |
| 0.5999999E-03 | -0.3805794E-04 | -0.3793319E-04 | -0.8351109E-03 | -0.3826813E-01 | -0.3722247E-01 | -0.9935239E+00 |
| 0.7000000E-03 | -0.4019092E-04 | -0.3993924E-04 | -0.9063298E-03 | -0.1040458E-01 | -0.9110950E-02 | -0.5118312E+00 |
| 0.8000000E-03 | -0.4134151E-04 | -0.4099797E-04 | -0.9536720E-03 | -0.1862052E-01 | -0.1827684E-01 | -0.5155923E+00 |
| 0.8999999E-03 | -0.4511767E-04 | -0.4483720E-04 | -0.1025723E-02 | -0.6291544E-01 | -0.6471980E-01 | -0.1005999E+01 |
| 0.9999999E-03 | -0.5512733E-04 | -0.5518459E-04 | -0.1171068E-02 | -0.1432905E+00 | -0.1484408E+00 | -0.1981863E+01 |

GRID NO. 20

| TIME | DISPLACEMENT U | DISPLACEMENT V | DISPLACEMENT W | VELOCITY U | VELOCITY V | VELOCITY W |
|---|---|---|---|---|---|---|
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.1000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.2000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.3000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.3999998E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5000001E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5999999E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.7000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.8000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.8999999E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.9999999E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

GRID NO. 21

| TIME | DISPLACEMENT U | DISPLACEMENT V | DISPLACEMENT W | VELOCITY U | VELOCITY V | VELOCITY W |
|---|---|---|---|---|---|---|
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.1000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.2000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.3000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.3999998E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5000001E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5999999E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.7000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.8000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.8999999E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.9999999E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

GRID NU. 22

| | DISPLACEMENT | | | VELOCITY | | |
|---|---|---|---|---|---|---|
| TIME | U | V | W | U | V | W |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.1000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.2000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.3000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.3999998E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5000001E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5999999E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.7000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.8000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.8999999E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.9999999E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

GRID NO. 23

| | DISPLACEMENT | | | VELOCITY | | |
|---|---|---|---|---|---|---|
| TIME | U | V | W | U | V | W |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.1000000E-03 | -0.2863510E-06 | -0.2174347E-05 | -0.9927613E-05 | -0.5556289E-02 | -0.4156290E-01 | -0.1896028E+00 |
| 0.2000000E-03 | -0.1377107E-05 | -0.7927764E-05 | -0.3613056E-04 | -0.1008809E-01 | -0.7158113E-01 | -0.3255052E+00 |
| 0.3000000E-03 | -0.2269821E-05 | -0.1610575E-04 | -0.7323867E-04 | -0.1359545E-01 | -0.9005487E-01 | -0.4077080E+00 |
| 0.3999998E-03 | -0.3762043E-05 | -0.2555388E-04 | -0.1158820E-03 | -0.1607832E-01 | -0.9698391E-01 | -0.4362099E+00 |
| 0.5000001E-03 | -0.5451343E-05 | -0.3511777E-04 | -0.1586908E-03 | -0.1753675E-01 | -0.9236854E-01 | -0.4110124E+00 |
| 0.5999999E-03 | -0.6633247E-05 | -0.4232350E-04 | -0.1913296E-03 | -0.7051948E-02 | -0.5451699E-01 | -0.2525317E+00 |
| 0.7000000E-03 | -0.7051846E-05 | -0.4657527E-04 | -0.2113505E-03 | -0.2270553E-02 | -0.3328855E-01 | -0.1586519E+00 |
| 0.8000000E-03 | -0.7277471E-05 | -0.4953527E-04 | -0.2252133E-03 | -0.3192554E-02 | -0.2868276E-01 | -0.1293730E+00 |
| 0.8999999E-03 | -0.7880471E-05 | -0.5286590E-04 | -0.2393782E-03 | -0.9817902E-02 | -0.4069967E-01 | -0.1646938E+00 |
| 0.9999999E-03 | -0.9431174E-05 | -0.5822936E-04 | -0.2603056E-03 | -0.2214673E-01 | -0.6933969E-01 | -0.2646165E+00 |

GRID NO. 24

| TIME | DISPLACEMENT U | DISPLACEMENT V | DISPLACEMENT W | VELOCITY U | VELOCITY V | VELOCITY W |
|---|---|---|---|---|---|---|
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.1000000E-03 | -0.1083420E-05 | -0.2397302E-05 | -0.2654265E-04 | -0.2096462E-01 | -0.4611840E-01 | -0.5083119E+00 |
| 0.2000000E-03 | -0.4052161E-05 | -0.8858159E-05 | -0.9715398E-04 | -0.3770632E-01 | -0.8127087E-01 | -0.8813704E+00 |
| 0.3000000E-03 | -0.8483923E-05 | -0.1828595E-04 | -0.1983083E-03 | -0.5022524E-01 | -0.1054575E+00 | -0.1119180E+01 |
| 0.3999998E-03 | -0.1395642E-04 | -0.2958407E-04 | -0.3164909E-03 | -0.5852117E-01 | -0.1186780E+00 | -0.1221735E+01 |
| 0.5000001E-03 | -0.2004742E-04 | -0.4165609E-04 | -0.4381477E-03 | -0.6259435E-01 | -0.1209329E+00 | -0.1189041E+01 |
| 0.5999999E-03 | -0.2431554E-04 | -0.5032124E-04 | -0.5295637E-03 | -0.2609240E-01 | -0.5786497E-01 | -0.6604914E+00 |
| 0.7000000E-03 | -0.2593063E-04 | -0.5432787E-04 | -0.5784866E-03 | -0.9532522E-02 | -0.2776172E-01 | -0.3791713E+00 |
| 0.8000000E-03 | -0.2688677E-04 | -0.5697238E-04 | -0.6126389E-03 | -0.1291464E-01 | -0.3062309E-01 | -0.3450776E+00 |
| 0.8999999E-03 | -0.2917828E-04 | -0.6155131E-04 | -0.6557435E-03 | -0.3623859E-01 | -0.6644869E-01 | -0.5582091E+00 |
| 0.9999999E-03 | -0.3479929E-04 | -0.7136102E-04 | -0.7325222E-03 | -0.7950491E-01 | -0.1352395E+00 | -0.1018572E+01 |

GRID NO. 25

| TIME | DISPLACEMENT U | DISPLACEMENT V | DISPLACEMENT W | VELOCITY U | VELOCITY V | VELOCITY W |
|---|---|---|---|---|---|---|
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.1000000E-03 | -0.2402670E-05 | -0.1069182E-05 | -0.2649039E-04 | -0.4621764E-01 | -0.2070655E-01 | -0.5073752E+00 |
| 0.2000000E-03 | -0.8976359E-05 | -0.4005888E-05 | -0.9698830E-04 | -0.8142006E-01 | -0.3735036E-01 | -0.8801472E+00 |
| 0.3000000E-03 | -0.1831952E-04 | -0.8403831E-05 | -0.1980331E-03 | -0.1056076E+00 | -0.4993153E-01 | -0.1118318E+01 |
| 0.3999998E-03 | -0.2963067E-04 | -0.1385674E-04 | -0.3161645E-03 | -0.1187799E+00 | -0.5844986E-01 | -0.1221886E+01 |
| 0.5000001E-03 | -0.4170839E-04 | -0.1995840E-04 | -0.4379239E-03 | -0.1209373E+00 | -0.6290561E-01 | -0.1190852E+01 |
| 0.5999999E-03 | -0.5038521E-04 | -0.2418413E-04 | -0.5281917E-03 | -0.5806529E-01 | -0.2511082E-01 | -0.6564982E+00 |
| 0.7000000E-03 | -0.5441462E-04 | -0.2568077E-04 | -0.5776202E-03 | -0.2798875E-01 | -0.8322597E-02 | -0.3740502E+00 |
| 0.8000000E-03 | -0.5707613E-04 | -0.2654889E-04 | -0.6113988E-03 | -0.3070769E-01 | -0.1254094E-01 | -0.3435365E+00 |
| 0.8999999E-03 | -0.6164933E-04 | -0.2888918E-04 | -0.6547184E-03 | -0.6622159E-01 | -0.3776550E-01 | -0.5648655E+00 |
| 0.9999999E-03 | -0.7141370E-04 | -0.3480226E-04 | -0.7327693E-03 | -0.1345315E+00 | -0.8399689E-01 | -0.1038134E+01 |

GRID NO. 26

| TIME | DISPLACEMENT U | DISPLACEMENT V | DISPLACEMENT W | VELOCITY U | VELOCITY V | VELOCITY W |
|---|---|---|---|---|---|---|
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.1000000E-03 | -0.2170476E-05 | -0.2805481E-06 | -0.9891000E-05 | -0.4149340E-01 | -0.5453363E-02 | -0.1889451E+00 |
| 0.2000000E-03 | -0.7915451E-05 | -0.1059150E-05 | -0.3601394E-04 | -0.7148969E-01 | -0.9961065E-02 | -0.3246374E+00 |
| 0.3000000E-03 | -0.1608518E-04 | -0.2241240E-05 | -0.7304341E-04 | -0.8998907E-01 | -0.1352314E-01 | -0.4070777E+00 |
| 0.3999998E-03 | -0.2552998E-04 | -0.3732250E-05 | -0.1156542E-03 | -0.9699136E-01 | -0.1613952E-01 | -0.4362649E+00 |
| 0.5000001E-03 | -0.3510027E-04 | -0.5437630E-05 | -0.1585215E-03 | -0.9249669E-01 | -0.1781030E-01 | -0.4122002E+00 |
| 0.5999999E-03 | -0.4229420E-04 | -0.6603347E-05 | -0.1910643E-03 | -0.5421118E-01 | -0.6556831E-02 | -0.2499249E+00 |
| 0.7000000E-03 | -0.4650823E-04 | -0.6959547E-05 | -0.2107600E-03 | -0.3289798E-01 | -0.1619898E-02 | -0.1552559E+00 |
| 0.8000000E-03 | -0.4943954E-04 | -0.7137876E-05 | -0.2243689E-03 | -0.2855689E-01 | -0.2999499E-02 | -0.1281928E+00 |
| 0.8999999E-03 | -0.5278536E-04 | -0.7770000E-05 | -0.2386520E-03 | -0.4118775E-01 | -0.1069558E-01 | -0.1687350E+00 |
| 0.9999999E-03 | -0.5824286E-04 | -0.9487551E-05 | -0.2603696E-03 | -0.7079101E-01 | -0.2470826E-01 | -0.2768841E+00 |

GRID NO. 27

| TIME | DISPLACEMENT U | DISPLACEMENT V | DISPLACEMENT W | VELOCITY U | VELOCITY V | VELOCITY W |
|---|---|---|---|---|---|---|
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.1000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.2000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.3000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.3999958E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5000001E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5999959E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.7000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.8000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.8999999E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.9999999E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

GRID NO. 28

| TIME | DISPLACEMENT U | DISPLACEMENT V | DISPLACEMENT W | VELOCITY U | VELOCITY V | VELOCITY W |
|---|---|---|---|---|---|---|
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.1000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.2000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.3000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.3999998E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5000001E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5999999E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.7000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.8000000E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.8999999E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.9999999E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

GRID NO. 1

| | STRESS | | | | | |
|---|---|---|---|---|---|---|
| TIME | SXX | SYY | SZZ | SXY | SXZ | SYZ |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5000001E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.9999999E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

GRID NO. 2

| TIME | SXX | SYY | SZZ | SXY | SXZ | SYZ |
|---|---|---|---|---|---|---|
| | STRESS | | | | | |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5000001E-03 | 0.2765334E+03 | 0.6452480E+03 | 0.2765334E+03 | -0.1012262E+02 | -0.1714765E+03 | 0.0 |
| 0.9999999E-03 | 0.4468408E+03 | 0.1042632E+04 | 0.4468408E+03 | -0.1907539E+02 | -0.2509308E+03 | 0.0 |

GRID NO. 3

| | STRESS | | | | | |
|---|---|---|---|---|---|---|
| TIME | SXX | SYY | SZZ | SXY | SXZ | SYZ |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5000001E-03 | -0.2517366E+03 | -0.2513616E+03 | -0.1397955E+03 | 0.3789848E+02 | 0.6412511E+02 | 0.6280046E+02 |
| 0.9999999E-03 | -0.4357820E+03 | -0.4336648E+03 | -0.2428735E+03 | 0.7525716E+02 | 0.9880966E+02 | 0.9710762E+02 |

GRID NO. 4

| | STRESS | | | | | |
|---|---|---|---|---|---|---|
| TIME | SXX | SYY | SZZ | SXY | SXZ | SYZ |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5000001E-03 | 0.6436406E+03 | 0.2758457E+03 | 0.2758457E+03 | -0.9884130E+01 | 0.0 | -0.1708669E+03 |
| 0.9999999E-03 | 0.1041236E+04 | 0.4462432E+03 | 0.4462432E+03 | -0.1836147E+02 | 0.0 | -0.2502704E+03 |

GRID No. 5

| | STRESS | | | | | |
|---|---|---|---|---|---|---|
| TIME | SXX | SYY | SZZ | SXY | SXZ | SYZ |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5000001E-03 | 0.8377444E+02 | 0.1954736E+03 | 0.8377449E+02 | 0.2499564E+02 | 0.2578418E+02 | 0.0 |
| 0.9999999E-03 | 0.1335305E+03 | 0.3115708E+03 | 0.1335306E+03 | 0.3964291E+02 | 0.6632878E+02 | 0.0 |

GRID NO. 6

| | STRESS | | | | | |
|---|---|---|---|---|---|---|
| TIME | SXX | SYY | SZZ | SXY | SXZ | SYZ |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5000001E-03 | 0.1830285E+03 | 0.4270664E+03 | 0.1330285E+03 | 0.1723236E+02 | -0.8776270E+02 | 0.0 |
| 0.9999999E-03 | 0.2944585E+03 | 0.6870715E+03 | 0.2944585E+03 | 0.2728899E+02 | -0.1119795E+03 | 0.0 |

GRID NU. 7

| TIME | SXX | SYY | SZZ | SXY | SXZ | SYZ |
|---|---|---|---|---|---|---|
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5000001E-03 | 0.1986108E+02 | 0.1972791E+03 | 0.6657388E+02 | 0.7730046E+02 | -0.3188586E+02 | -0.9735374E+01 |
| 0.9999995E-03 | 0.3474673E+02 | 0.3441958E+03 | 0.1193960E+03 | 0.1310131E+03 | -0.6523181E+02 | -0.2355817E+02 |

GRID NO. 8

| TIME | SXX | SYY | SZZ | SXY | SXZ | SYZ |
|---|---|---|---|---|---|---|
| | | | STRESS | | | |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5000001E-03 | -0.1386699E+03 | -0.9358392E+02 | -0.6312944E+02 | 0.8888091E+02 | -0.4237683E+02 | 0.5040901E+02 |
| 0.9999999E-03 | -0.2311674E+03 | -0.1357612E+03 | -0.9842067E+02 | 0.1564008E+03 | -0.6994542E+02 | 0.7579324E+02 |

GRID NU. 9

| | STRESS | | | | | |
|---|---|---|---|---|---|---|
| TIME | SXX | SYY | SZZ | SXY | SXZ | SYZ |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5000001E-03 | -0.9310439E+02 | -0.1382177E+03 | -0.6251440E+02 | 0.8840721E+02 | 0.5033195E+02 | -0.4258542E+02 |
| 0.9999999E-03 | -0.1358129E+03 | -0.2293911E+03 | -0.9790340E+02 | 0.1559442E+03 | 0.7532999E+02 | -0.7070065E+02 |

GRID NO. 10

| TIME | SXX | SYY | SZZ | SXY | SXZ | SYZ |
|---|---|---|---|---|---|---|
| | | | STRESS | | | |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5000001E-03 | 0.1973320E+03 | 0.2006250E+02 | 0.6684766E+02 | 0.7686929E+02 | -0.9168534E+01 | -0.3231160E+02 |
| 0.9999999E-03 | 0.3445352E+03 | 0.3594531E+02 | 0.1199766E+03 | 0.1307341E+03 | -0.2265033E+02 | -0.6647769E+02 |

GRID NU. 11

| TIME | SXX | SYY | SZZ | SXY | SXZ | SYZ |
|---|---|---|---|---|---|---|
| | | | STRESS | | | |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5000001E-03 | 0.4262881E+C3 | 0.1826950E+03 | 0.1826950E+03 | 0.1740248E+02 | 0.0 | -0.8762856E+02 |
| 0.9999999E-03 | 0.6864578E+03 | 0.2941956E+03 | 0.2941956E+03 | 0.2766103E+02 | 0.0 | -0.1112579E+03 |

GRID NO. 12

| TIME | SXX | SYY | SZZ | SXY | SXZ | SYZ |
|---|---|---|---|---|---|---|
| | STRESS | | | | | |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5000001E-03 | 0.1950210E+03 | 0.8358041E+02 | 0.8358044E+02 | 0.2512367E+02 | 0.0 | 0.2578345E+02 |
| 0.9999999E-03 | 0.3111130E+03 | 0.1333342E+03 | 0.1333343E+03 | 0.3983757E+02 | 0.0 | 0.6661612E+02 |

GRID NO. 13

| | STRESS | | | | | |
|---|---|---|---|---|---|---|
| TIME | SXX | SYY | SZZ | SXY | SXZ | SYZ |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5000001E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.9999999E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

GRID NO. 14

STRESS

| TIME | SXX | SYY | SZZ | SXY | SXZ | SYZ |
|---|---|---|---|---|---|---|
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5000001E-03 | -0.7025522E-01 | -0.1637865E+00 | -0.7025522E-01 | 0.6011625E+00 | -0.1712396E+03 | 0.0 |
| 0.9999999E-03 | 0.5117541E-01 | 0.1188396E+00 | 0.5117541E-01 | 0.3368624E-01 | -0.2510887E+03 | 0.0 |

GRID NO. 15

| TIME | SXX | SYY | SZZ | SXY | SXZ | SYZ |
|---|---|---|---|---|---|---|
| | ------------------ | ------------------ | ------------------ | STRESS | ------------------ | ------------------ |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5000001E-03 | -0.5842536E+00 | -0.5100349E+00 | -0.2889298E+01 | -0.1932631E+00 | 0.6405296E+02 | 0.6276367E+02 |
| 0.9999999E-03 | -0.4790291E-01 | 0.1669407E+00 | 0.5405701E+00 | -0.1226196E+00 | 0.9860158E+02 | 0.9691211E+02 |

GRID NO. 16

| TIME | SXX | SYY | SZZ | SXY | SXZ | SYZ |
|---|---|---|---|---|---|---|
| | | | STRESS | | | |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5000001E-03 | -0.3398437E+00 | -0.1455078E+00 | -0.1455078E+00 | 0.6069641E+00 | 0.0 | -0.1706357E+03 |
| 0.9999999E-03 | -0.2250977E+C0 | -0.9667969E-01 | -0.9667969E-01 | 0.7009888E-01 | 0.0 | -0.2504495E+03 |

GRID NO. 17

| | ----------------------------------- | STRESS | ----------------------------------- | | | |
|---|---|---|---|---|---|---|
| TIME | SXX | SYY | SZZ | SXY | SXZ | SYZ |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5000001E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.9999999E-03 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

GRID NO. 18

| TIME | SXX | SYY | SZZ | SXY | SXZ | SYZ |
|---|---|---|---|---|---|---|
| | STRESS | | | | | |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5000001E-03 | -0.2766711E+03 | -0.6455674E+03 | -0.2766711E+03 | 0.1132715E+02 | -0.1707418E+03 | 0.0 |
| 0.9999999E-03 | -0.4467388E+03 | -0.1042392E+04 | -0.4467388E+03 | 0.1914142E+02 | -0.2509135E+03 | 0.0 |

GRID NO. 19

| TIME | SXX | SYY | SZZ | SXY | SXZ | SYZ |
| --- | --- | --- | --- | --- | --- | --- |
| | | | STRESS | | | |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5000001E-03 | 0.2505681E+03 | 0.2503454E+03 | 0.1341614E+03 | -0.3828046E+02 | 0.6424973E+02 | 0.6299609E+02 |
| 0.9999999E-03 | 0.4356628E+03 | 0.4339792E+03 | 0.2440640E+03 | -0.7550372E+02 | 0.9873969E+02 | 0.9706885E+02 |

GRID NO. 20

| TIME | SXX | SYY | SZZ | SXY | SXZ | SYZ |
|---|---|---|---|---|---|---|
| | | | STRESS | | | |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5000001E-03 | -0.6443118E+03 | -0.2761331E+03 | -0.2761331E+03 | 0.1110037E+02 | 0.0 | -0.1701431E+03 |
| 0.9999999E-03 | -0.1041692E+04 | -0.4464382E+03 | -0.4464382E+03 | 0.1850177E+02 | 0.0 | -0.2502930E+03 |

GRID NO. 21

| TIME | SXX | SYY | SZZ | SXY | SXZ | SYZ |
|---|---|---|---|---|---|---|
| | STRESS | | | | | |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5000001E-03 | -0.8360547E+02 | -0.1950794E+03 | -0.8360551E+02 | -0.2467168E+02 | 0.2610762E+02 | 0.0 |
| 0.9999999E-03 | -0.1334970E+03 | -0.3114939E+03 | -0.1334971E+03 | -0.3961824E+02 | 0.6633960E+02 | 0.0 |

GRID NO. 22

| | STRESS | | | | | |
|---|---|---|---|---|---|---|
| TIME | SXX | SYY | SZZ | SXY | SXZ | SYZ |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5000001E-03 | -0.1829309E+03 | -0.4268389E+03 | -0.1829309E+03 | -0.1646916E+02 | -0.8725639E+02 | 0.0 |
| 0.9999999E-03 | -0.2943862E+03 | -0.6869016E+03 | -0.2943862E+03 | -0.2723235E+02 | -0.1119594E+03 | 0.0 |

GRID NO. 23

| TIME | SXX | SYY | SZZ | SXY | SXZ | SYZ |
|---|---|---|---|---|---|---|
| | | | STRESS | | | |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5000001E-03 | -0.2160764E+02 | -0.1985686E+03 | -0.7367216E+02 | -0.7681546E+02 | -0.3185635E+02 | -0.9581299E+01 |
| 0.9999999E-03 | -0.3461650E+02 | -0.3436082E+03 | -0.1193578E+03 | -0.1309791E+03 | -0.6523285E+02 | -0.2355713E+02 |

GRID NO. 24

| | STRESS | | | | | |
|---|---|---|---|---|---|---|
| TIME | SXX | SYY | SZZ | SXY | SXZ | SYZ |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5000001E-03 | 0.1381934E+03 | 0.9369730E+02 | 0.5802287E+02 | -0.8887448E+02 | -0.4255211E+02 | 0.5056738E+02 |
| 0.9999999E-03 | 0.2312153E+03 | 0.1363482E+03 | 0.9875119E+02 | -0.1564528E+03 | -0.6997612E+02 | 0.7576978E+02 |

GRID NO. 25

| | STRESS | | | | | |
|---|---|---|---|---|---|---|
| TIME | SXX | SYY | SZZ | SXY | SXZ | SYZ |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5000C01E-03 | 0.9298544E+02 | 0.1378956E+03 | 0.5806371E+02 | -0.8844954E+02 | 0.5043042E+02 | -0.4275635E+02 |
| 0.9999999E-03 | 0.1356675E+03 | 0.2294449E+03 | 0.9814737E+02 | -0.1560166E+03 | 0.7529434E+02 | -0.7068311E+02 |

GRID NO. 26

| TIME | SXX | SYY | SZZ | SXY | SXZ | SYZ |
|---|---|---|---|---|---|---|
| | | | STRESS | | | |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5000001E-03 | -0.1991094E+03 | -0.2192578E+02 | -0.7370703E+02 | -0.7641629E+02 | -0.9049774E+01 | -0.3230835E+02 |
| 0.9999999E-03 | -0.3446914E+03 | -0.3596484E+02 | -0.1199258E+03 | -0.1306871E+03 | -0.2266919E+02 | -0.6645679E+02 |

GRID NO. 27

STRESS

| TIME | SXX | SYY | SZZ | SXY | SXZ | SYZ |
|---|---|---|---|---|---|---|
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5000001E-03 | -0.4261392E+C3 | -0.1826310E+03 | -0.1826310E+03 | -0.1662276E+02 | 0.0 | -0.8711792E+02 |
| 0.9999999E-03 | -0.6865764E+03 | -0.2942473E+03 | -0.2942473E+03 | -0.2755283E+02 | 0.0 | -0.1112644E+03 |

GRID NO. 28

| TIME | SXX | SYY | SZZ | SXY | SXZ | SYZ |
|---|---|---|---|---|---|---|
| | STRESS | | | | | |
| 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.5000001E-03 | -0.1946046E+03 | -0.8340193E+02 | -0.8340193E+02 | -0.2479903E+02 | 0.0 | 0.2611035E+02 |
| 0.9999999E-03 | -0.3111086E+03 | -0.1333321E+03 | -0.1333321E+03 | -0.3979353E+02 | 0.0 | 0.6661841E+02 |

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**13. ABSTRACT** *(Maximum 200 words)*

The programming aspects of SFENES are described in the User's Manual. The information presented here is provided for the installation programmer. It is sufficient to fully describe the general program logic and required peripheral storage. All element generated data is stored externally to reduce required memory allocation. A separate section is devoted to the description of these files thereby permitting the optimization of I/O time through efficient buffer description. Individual subroutine descriptions are presented along with the complete Fortran source listings. A short description of the major control, computation, and I/O phases is included to aid in obtaining an overall familiarity with the program's components. Finally, a discussion of the suggested overlay structure which allows the program to execute with a reasonable amount of memory allocation is presented.

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